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WATER QUALITY MANAGEMENT CONFERENCE

SPONSORED BY THE

ONTARIO WATER RESOURCES COMMISSION

November 21 and 22, 1961

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Water quality management
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TORONTO, ONTARIO

ONTARIO WATER RESOURCES COMMISSION

CONFERENCE ON WATER QUALITY MANAGEMENT

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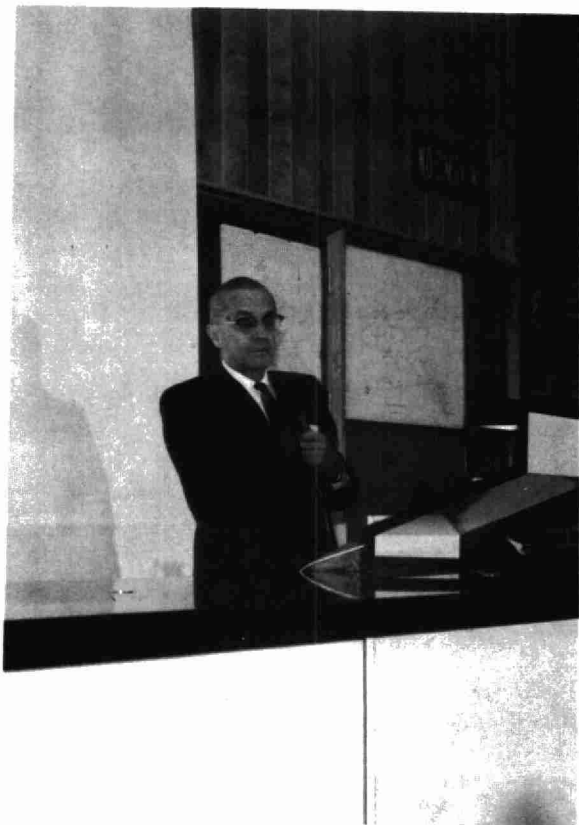
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Tuesday, November 21, 1961

PART A --
AN INVENTORY OF THE SITUATION

Morning Session

Laboratory Building
Ontario Water Resources Commission

Chairman A. M. Snider of the Ontario Water Resources Commission, after welcoming those in attendance, opened the Conference with the following remarks--

"We are here to study the main phases of water quality and to assess what has been done to ensure protection of our greatest asset, water. This conference is complementary to last year's Ontario Conference on Co-ordinated Water Pollution Control, and this time we will discuss the broader subject of Water Quality Management."

After conveying a message of regret from Hon. Fred M. Cass, Q.C., Minister of Municipal Affairs who reports to the Ontario Legislature for the Commission, who was unable to attend the opening session of the conference, Mr. Snider called upon Dr. A. E. Berry, general manager of the OWRC, to set forth the objectives of the conference.

OPENING STATEMENT

Dr. A. E. Berry, General Manager
Ontario Water Resources Commission



It would appear appropriate that at the opening of this conference a statement of objectives be set forth, so that we may have a clear concept of the program, and what the aims are. It is believed that the papers and discussions in the agenda will be found to be timely and instructive, and that there will be much to be gained by meeting together to review problems which should be of concern to everyone in Ontario.

It will be recalled that in 1960 the first of these conferences was held here, and that it dealt with "Co-ordinated Water Pollution Control". That was a meeting productive of stimulating thoughts, at the conclusion of which there was little doubt but that it should be followed by a similar one this year. The theme chosen now is "Water Quality Management", a somewhat broader approach to these problems than last year. Once again this is not to be a highly technical meeting, but rather one dealing with practices and procedures in the management of our water resources aimed at preserving them against the damaging effects of pollution.

In the first place it can be indicated that the Water Resources Commission would like to review certain matters with representative groups of people who have special interests in municipal administration, industrial activities, public health, conservation, agriculture, engineering, recreation, and many other fields of human endeavour directed to the welfare of the people of this province. The Commission is desirous of not only reviewing the progress since its creation in 1956, but also hopes to obtain the assistance and guidance of all here towards improving its program and accelerating its pace towards an objective to which we can all subscribe with interest and enthusiasm.

It will be difficult to visualize any more worthy or necessary objective than the protection and beneficial use of our water resources. The world today is gaining an ever-clearer concept of the part that water resources must play in our development and well-being. This is made plain by activities all over this continent. Pollution is one of the serious dangers against these same water resources. If we are to manage these waters to meet our many needs there must be adequate control over all of the many kinds of pollutants. As the population grows and industry expands not only is more water needed, but it must be used over and over again as it journeys from its first contact with the earth to the ocean. Our task is a direct one of the greatest importance and there is no time for delay. This was well expressed by Justice Oliver Wendell Holmes when he said, "A river is more than an amenity, it is a treasure. It offers a necessity of life that must be rationed among those who have power over it."

This year's program is divided into two main parts, the first being an inventory of the situation as it exists today, the second an assessment of our needs. Thus, there will be an examination of the water resources of the province to look closely at what we possess in relation to our likely needs. The Commission has now been working on its program since 1956. It is proposed to examine that program, especially in respect to the protection of waters against pollution, and to point out what work yet remains to be done. This will be supplemented by a discussion on the status of stream sanitation, since this is the ultimate criterion on the success of any program in water quality management.

A series of papers to be presented will deal with some new or unusual circumstances. One of these will review that problem, most annoying in many places, of algal growths in water, and reveal the steps being taken to meet this. Nuclear contamination of water is now of general concern. What will be the effects of fallout, and what must be our program in case of nuclear warfare to preserve and utilize our water resources? An opportunity to examine this problem is presented. Much has been heard in recent years on the growing significance of industrial wastes discharged to watercourses. The many new products coming onto the market bring with them perplexing questions on what will be the effects on humans and on aquatic life, both of the products themselves and of the wastes resulting from their manufacture. Finally, it is proposed to evaluate the legislation under which the program for water quality management operates. Is it sufficient or would it be desirable to seek other measures?

The foregoing papers will constitute the inventory of what facilities we have, and what progress we have made. There will be an opportunity for a full discussion of these subjects and an exchange of views among all present. The Commission will welcome the suggestions coming from these discussions.

The second day of the conference, containing part B, will be given over chiefly to an assessment of what is needed and how we can achieve a full program in water quality management. This will be done by the presentation of a number of papers and by the use of "Guided Discussions". The latter is being used to secure the views of as many people as possible. Thus, wide discussion is invited on the subjects of the water resources needs of the future, the financing of waste treatment works, the use of industrial waste by-laws, and a searching analysis of water quality management problems. The relationship between air and water pollution needs careful examination and plans for their control. Water storage is also to be given scrutiny. What storage facilities do we have or what can be provided? How can this stored water be used to improve the stream flow in the dry period? This will be open for discussion by this assembled group. Similarly, great emphasis is now felt to be imperative in research on water quality and means to ensure good quality. That will be part of the program placed before the conference.

This is an outline of what is being attempted in the program itself. It has been prepared to serve a useful purpose in planning for water quality management in the future. The assistance and co-operation of all are required in this task. Valuable direction is expected to come from this gathering of persons with a common interest.

This conference offers a number of other opportunities, one of the important ones being the informal discussions which always take place when people come together. There will be a period for inspection of this very modern and serviceable laboratory building, an important part of the facilities available for water quality control. All in attendance are invited to inspect the exhibits on the lower floor of the building. Literature will also be on display, and finally the proceedings of the conference are to be recorded and published as a complete book. Copies will be sent to all who register, and in this way the value of the conference can be utilized to the maximum.

Important events are scheduled for the Tuesday night banquet. This social hour in the King Edward Sheraton Hotel will provide an enjoyable interlude between the two parts of the program. It will also provide the conference with an opportunity to hear the newly-appointed Minister of Municipal Affairs, the Honourable Fred M. Cass, and to meet the members of the Water Resources Commission and many others.

One of the notable features of the banquet will be the presentation of two awards. It will be the wish of all to give tangible recognition to those who have made outstanding contributions to water pollution control. For this purpose an award was created last year to be known as the Distinguished Service Award in recognition and appreciation of distinguished public service in water pollution control. The recipients this year are two who have met the most rigid requirements in the persons of the Honourable Charles S. MacNaughton and Ross L. Clark. These Awards will be presented at the banquet.

In summary, one would appear justified in concluding that the plans in this conference contain the ingredients for a successful event when success is measured in terms of a joint approach to the important task of conserving our water resources against the degrading and wasteful effects of pollution. The conclusion of this 1961 meeting will enable us to examine our accomplishments and determine what our next course of action should be.

THE WATER RESOURCES OF ONTARIO

A. K. Watt and K. E. Symons

Water Resources Division
Ontario Water Resources Commission

presented by

Mr. Watt



The people of Ontario are particularly fortunate in the amount and quality of water they possess. Most of the southern boundary of the province is made up of the Great Lakes and St. Lawrence Waterway. This is the most important inland waterway in the world with Lake Superior being the world's largest body of fresh water.

Seventeen percent of the total area of the province is made up of lakes and rivers. One half of this water area lies within the great lakes system which has a storage capacity of 5,457 cubic miles.

Precipitation in the form of rain and snow is the source of essentially all of our water resources. The average annual precipitation varies from less than 20 inches in the extreme northwest sections of the province to more than 38 inches in the south-central portions. A small area east of Lake Superior has an average annual precipitation in excess of 40 inches. In attempting to take an inventory of our water resources we might assume that this precipitation averages 28 inches in northern Ontario and 33 inches in southern Ontario. This water is available for use within the various watersheds of the province. However, ninety-eight percent of the people in the province live within the Great Lakes-Upper St. Lawrence and the Ottawa River basins. For the remainder of the paper our attention will be focussed on the water resources of this area.

The accompanying map of the Great Lakes and Ottawa River drainage basins includes a few selected river basins for comparison purposes. The mean annual precipitation in inches is shown graphically on or beside each river basin along with the mean annual run-off in inches. It will be noted that there is a higher proportion of annual run-off from river basins such as the Ganaraska, the French and the Saugeen where sand and gravel deposits are more prevalent within the basin, than in such river basins as the Thames, Grand, Credit and Trent.

A table has been prepared which shows the ratio of run-off to precipitation along with the ratio of the 3-month flood flow to annual flow. The ratios can be changed to percentages readily by multiplying by 100. Three river basins within the Hudson Bay drainage system are included for comparison purposes. It is significant that at least 50 percent of the precipitation falling on these northern river basins is available as run-off. The Ganaraska has the second highest percentage of run-off with only 40 percent of the total precipitation within the watershed lost to evapo-transpiration processes. In examining the ratio of 3-month flood flow to annual flow, the effect of control works on the streams should be kept in mind. Fifty-three percent of the annual discharge from the Credit and the Saugeen Rivers, where there is no flow control, takes place in a 3-month period. It is significant that a higher percentage of flood run-off takes place on the Grand and Thames Rivers where there is some flow control. The more control that is exercised on a river flow, the lower

the ratio should be in the last column. This is apparent in the ratio figures for the French, Trent and St. Lawrence Rivers. Other factors affecting these ratios will be the geological conditions within the river basins including the youthfulness of the streams.

The mean annual run-off from the Ottawa River Basin is 16.4 inches. This is approximately equal to the calculated run-off from the inland areas of Ontario within the Great Lakes Basin shown in the next table. It compares with an average annual run-off of 13.9 inches from the selected Atlantic Drainage Basins shown in Table 2. The difference is explained in part by the variation in precipitation and run-off characteristics on the various units of the larger basin including the land areas immediately south of the Great Lakes.

In Table 3 an attempt is made to estimate the amount of water available for use on the inland areas of the Great Lakes-Upper St. Lawrence and Ottawa basins. Bruce and Rodgers¹ have studied a number of methods by several authors for arriving at the total evaporation from Lake Ontario and have estimated that it would amount to 2.7 feet in one year. If this were true throughout the basin under study it would mean that all of the precipitation on the surfaces of the Great Lakes is lost to use because of evaporation. The usable water within the basin would, therefore, have to come from the precipitation falling on the land surfaces. In proportioning the mean annual run-off, Ontario's land surface would contribute 105,000 cubic feet per second which is equivalent to 56,500 million gallons per day or 16.3 inches per year. In a similar manner, amounts are obtained for Ontario's contribution to the Ottawa River basin making an overall total of 69,000 million gallons per day.

The amount of 69,000 is, therefore, the total run-off from these two major water systems within the area occupied by 98 percent of Ontario's population. This total cannot be considered as a dependable supply throughout the year. It was shown in the previous table that a high proportion of the annual flow was lost through flood run-off in a 3-month period. The flood run-off for the selected drainage basins shown in Table 2 averaged 50 percent of the mean annual discharge in spite of the fact that a number of these basins had some control over the run-off. Some hydrologists have rated the percentage of flood run-off in the United States as high as two-thirds of the annual flow.

¹ Bruce, J. P. and Rodgers, G. K. (1959) "The Water Balance of the Great Lakes System" Paper presented at the Symposium on the Great Lakes A.A.A.S. Chicago.

It is possible to retain some of the flood water, of course, by storage and diversion. By such measures and through conservation practices we have assumed that eventually most of the balance of the mean annual flow will be available for dependable use. Thus in the second column of Table 3 after making allowance for flood and storage factors the amount of dependable flow is reduced to 34,300 million gallons a day.

No allowance has been made yet for the amount of water needed for waste dilution and fish and wildlife. This amount will vary from stream to stream. Lacking reliable information for measuring these needs we have simply used the factor of 50 percent of the dependable flow and the same factor that was applied in a similar analysis by resource investigators in the United States. This appraisal of our water supplies indicates that there is in the order of 14 billion gallons in the Great Lakes-Upper St. Lawrence Basin and 3.1 billion gallons of water in the Ottawa River Basin making a total of 17.1 billion gallons of dependable flow available for withdrawal.

A high proportion of the stream flow has been ground water which has discharged into the river channels and its tributaries to maintain the base flow of the stream. The geological conditions within the watershed areas are responsible to a large degree for the amount of infiltration that takes place after precipitation and the amount that flows off directly as run-off. The geological map of Ontario shows the area underlain by Precambrian rocks - the granites, gneisses and other crystalline soils types - which are not generally good water-bearing formations. Palaeozoic rocks represented by the Ordovician, Silurian and Devonian systems have variable water-bearing characteristics. Shale formations are poor aquifers and these underlie extensive areas in southern Ontario. The limestone and dolomite rocks are the best water yielding formations and these occur mostly in the eastern and western parts of southern Ontario.

In spite of poor water-bearing conditions in the bedrocks an area can still have good water possibilities if the overburden conditions are favourable. The map of the physiographic regions in southern Ontario shows the great variety of glacial features which are characterized by different soil conditions. The kames, kame moraines, eskers, sand plains, beach deposits and spillway areas are the areas where maximum infiltration takes place during precipitation. They are the best source areas of ground water recharge.

Having arrived at an estimate of the amount of water available for withdrawal and observed briefly some of the geological factors which affect that supply, an attempt will now be made to assess the extent of present water use. The population density map of the province

shows the concentration of persons around the western portion of Lake Ontario and in the southwestern areas of the province generally. In these areas the maximum withdrawals of water for municipal, irrigation, and much of the industrial uses are made.

Municipal water systems in Ontario presently withdraw about 600 million gallons of water per day. This amount includes water supplied to industry from the municipal systems. One system withdraws over 100 million gallons a day, four systems withdraw between 10 and 100 million gallons a day, and 64 systems between 1 and 10 million gallons a day. Some additional 220 systems withdraw less than one million gallons a day.

Irrigation use of water is increasing. The irrigation of tobacco, truck and fruit crops has been practised for some time. There is a trend towards the irrigation of other crops such as farm pasture. It is difficult to determine the average amount of water withdrawal for irrigation, particularly when some crops such as tobacco are rotated. An estimate of one billion gallons a day is probably quite high but it might be used as a figure that could be realistic, during a dry summer period.

Industry is the biggest user of water. In Table 4 a comparison is made between private industrial use of water and municipally supplied water in five counties for which water resource surveys were carried out in recent months. It will be seen that as much as ten times the total municipal production was used by private industry. However, the factor of 4 to 5 times the municipal use is generally used to arrive at a figure for total private industrial use. This would bring the total of industrial use to 3,000 million gallons a day exclusive of water use by hydro and thermal generating stations.

The table shows some interesting facts about per capita consumption which varies from 44 gallons per capita per day in Haldimand County to 166 in Welland County. The source of supply is almost entirely ground water in Waterloo County and surface water in other counties.

The use of water for power development has not been included in the estimated 3,000 million gallons a day used by industry. The accompanying map shows the locations of 62 hydro developments of the Hydro Electric Power Commission of Ontario and various companies. Table 5 gives the average annual values of the amounts of water used for thermal and hydro generating stations of the Ontario Hydro Electric Power Commission. It is apparent that the hydro generating stations alone use more than 100 billion gallons of water in excess of the mean annual run-off from the basins under consideration in the paper. Since most of the power developments are within the Great Lakes-Upper St. Lawrence or Ottawa basins it is obvious that considerable re-use of water is being made.

No mention has been made so far of the amount of water being used by private domestic systems. Two million of the six million people in Ontario have to supply their own water. If we assume they use 50 gallons per capita per day another 100 million gallons are added to the total use. This withdrawal for domestic, municipal, industrial and irrigation purposes, exclusive of hydro use, now totals 4.7 billion gallons a day compared to the 17.1 billions of manageable water available for withdrawal.

Therefore, somewhere between one-third to one-quarter of the available water supplies in this area are presently being withdrawn for use. The proportion is actually much more favourable than that. Not all of the water withdrawn is consumed. Much of it is available for re-use.

Using percentage figures for actual water consumption that have been determined by the United States Geological Survey¹ for each of the use categories just examined, a total consumption figure of approximately 1.1 billion gallons a day is obtained.

	Amount Withdrawn MGD	Percent Consumed	Amount Consumed MGD
Public Supply	600	17	100
Industrial	3000	16	480
Irrigation	1000	47	470
Private Domestic	100	78	78
Total			1,128 = 1.1 BGD

Provided that the water withdrawn is not polluted to the extent that re-use is not possible, or that the cost of treatment to remove the pollution is not prohibitive, approximately 16 times the present use of water can be made before using up the 17.1 billion gallons of water available for withdrawal.

If the present rate of increase in the use of water continues, this surplus will not last for many more decades unless more effective management of this resource is achieved.

The map of the drainage basins of southern Ontario shows the tremendous possibilities for water management. An important contribution in the field is being made by the various Valley Authorities under the leadership of the Conservation Branch of the Department of Commerce and Development. The activities of the Ontario Water Resources Commission are devoted entirely to the management of our water resources by

¹ MacKichan, K. A. "Water Use in the United States"

helping water users develop available supplies and by promoting effective control of all types of water pollution.

In summary we might refer to the chart which shows diagrammatically our estimates of the amount of water available for withdrawal, amount used, and amount consumed. The 17.1 billion of gallons of water available daily for withdrawal within the watershed of the Great Lakes-Upper St. Lawrence Waterway and Ottawa River represent approximately $1/8$ of the mean annual precipitation or $1/4$ of the mean annual run-off from the land surface. Present withdrawals, excluding hydro use, are estimated at 4.7 billion gallons a day of which 64 percent is private industrial use, 21 percent irrigation, 13 percent municipal and two percent private domestic. An estimated 1.1 billion gallons are actually consumed through evapo-transpiration or product-forming processes. Although three times as much water is used for industry than for irrigation the actual consumptions are about equal because of the high evapo-transpiration loss of irrigation water.

Throughout this assessment of our water resources no mention has been made of the application of conservation methods on land surfaces within the watersheds. These will help reduce the flood run-off and improve the water quality. Only brief reference has been made to the importance of dams in helping to maintain dependable flow. There are, however, some practical limitations of impoundments. We will hear more of the extent of these and their effect on water quality later in this conference.

No reference has been made to the possibility of drawing on the 5.5 thousand cubic miles of fresh water stored in the great lakes, to the hidden reservoirs of ground water which may equal the surface supply, or to the possibility of major diversions from the rivers of the Hudson Bay drainage system which are likely to take place in the future when the need arises. All of these possibilities suggest that our water reserves are tremendous and that there is no immediate shortage but these withdrawals and diversions introduce the problem of water and property rights which have political and legal implications.

The introduction of water use legislation by the Commission early in the year controlling the taking of water for most purposes by permit is a notable beginning towards the equitable management of our water resources.

This review of our water resources indicates that a detailed assessment of water withdrawal and consumption in Ontario at present is overdue. The estimates made for these may not be too accurate but they are sufficiently reliable to indicate that the people in the Great Lakes-Upper St. Lawrence and Ottawa basins will have to pay more attention in the immediate future to the management of water through conservation and pollution control programmes than has been done in the past. The alternative is high cost water through diversion from northern watersheds or costly treatment of polluted water within the basin. It would seem more realistic if we were to make maximum use of what we have through wise water management.

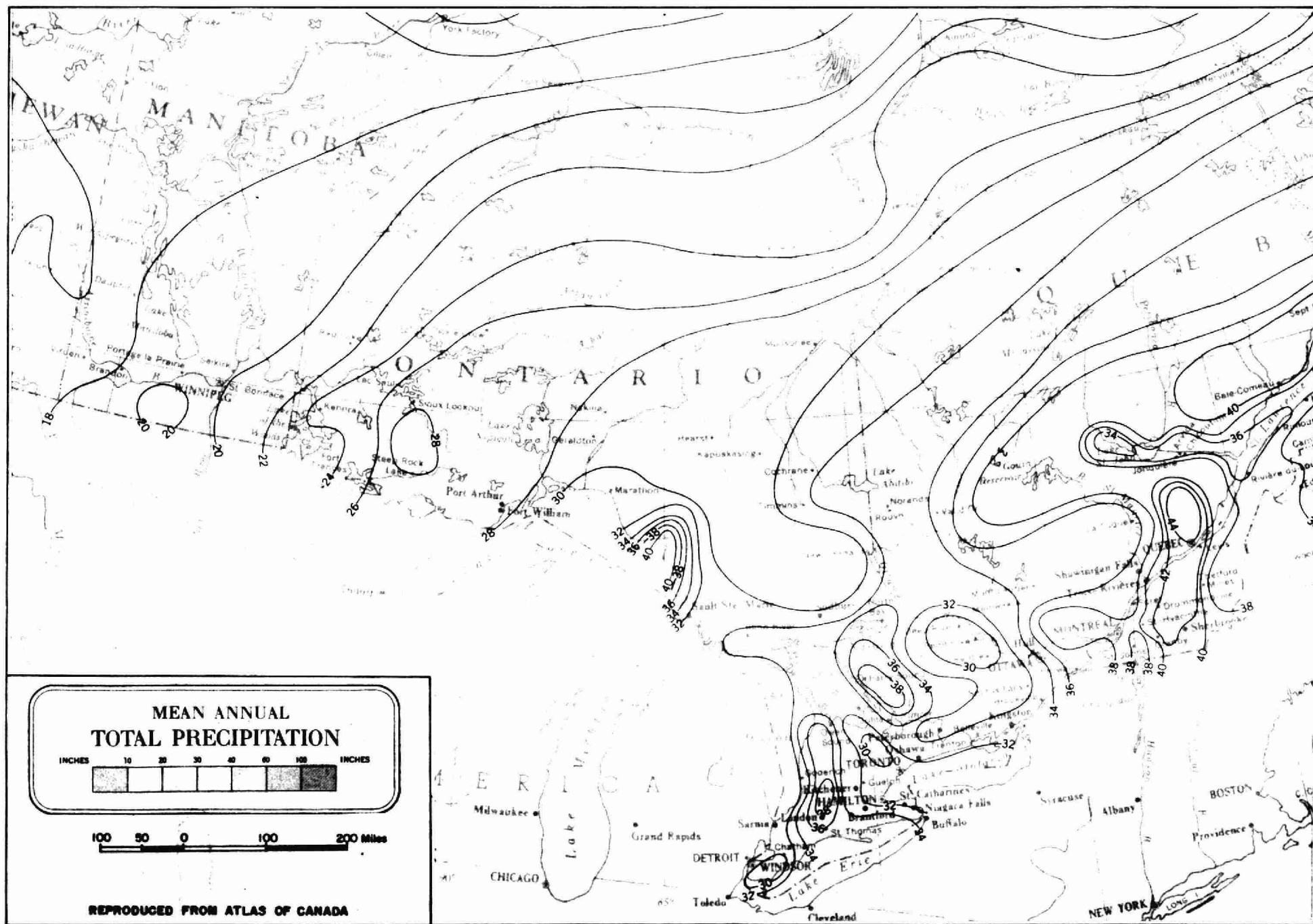
TABLE 1.

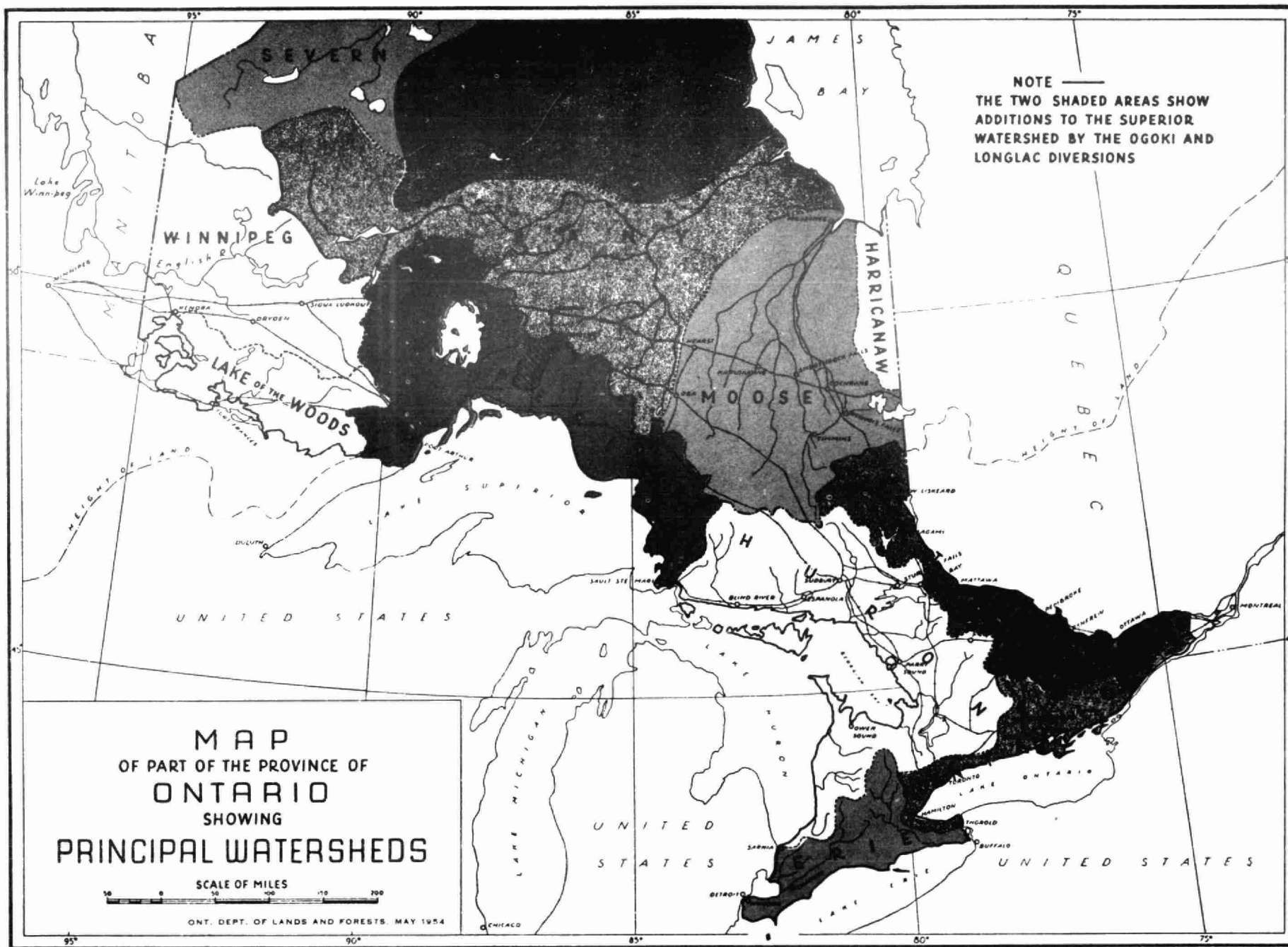
GREAT LAKES STATISTICS

LAKE	LENGTH	WIDTH	ELEVATION ABOVE MEAN SEA LEVEL	DEPTH		AREA OF WATER		AREA OF DRAINAGE		STORAGE CAPACITY
				AVERAGE	MAXIMUM	SURFACE		BASIN		
						TOTAL	ONTARIO	TOTAL	ONTARIO	
	miles	miles	feet	feet	feet	sq mi	sq mi			cu mi
SUPERIOR	383	160	602.2	489	1,302	31,820		80,900		2,935
MICHIGAN	321	118	580.8	-	923	22,400		69,040		1,170
HURON	247	101	580.8	168	748	23,010		72,420		849
ST. CLAIR	26	24	575.3	11	23	460		6,420		-
ERIE	241	57	572.4	60	208	9,940		34,680		110
ONTARIO	193	53	245.9	250	774	7,540		34,630		393
TOTAL						95,170		298,090		5,457

Sources of Information

Mostly from Publications of the
Hydrographic Service, Department
of Mines and Technical Surveys,
Ottawa.





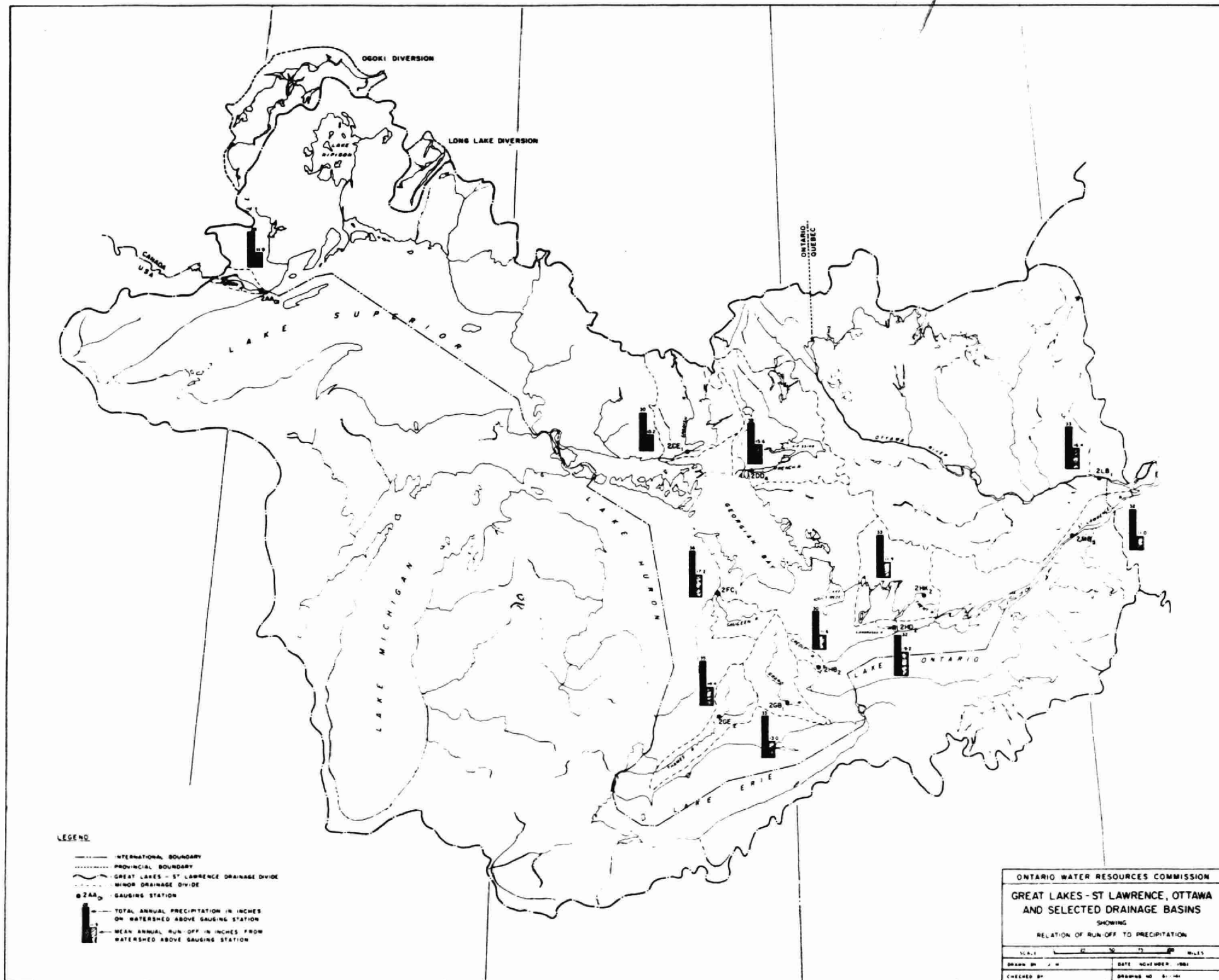


TABLE 2.

PRECIPITATION AND RUN-OFF VALUES FOR SELECTED RIVER BASINS

River Basin	Gauging Station Number	Area Above Station	Mean Annual Precipitation	Mean Annual Discharge	Run-off	Ratio of Runoff to Precipitation	Ratio of 3-month flood flow to Annual flow*
		sq mi	in.	cfs	in.		
HUDSON BAY DRAINAGE							
Abitibi	4ME ₂	8,440	32	10,900	17.6	0.55	0.41
Mattagami	4LG ₁	13,400	30	14,800	15.0	0.50	0.56
Harricanaw	4NA ₁	1,400	34	2,130	20.7	0.61	0.47
ATLANTIC DRAINAGE							
Pigeon	2AA ₀₁	600	28	525	11.9	0.42	0.67
Spanish	2CE ₁	4,655	30	4,530	13.2	0.44	0.40
French	2DD ₄	5,370	32	6,120	15.6	0.49	0.39
Saugeen	2FC ₁	1,565	36	1,980	17.2	0.48	0.53
Thames	2GE ₂	1,205	35	1,270	14.4	0.41	0.58
Grand	2GB ₁	2,010	33	1,930	13.0	0.39	0.55
Credit	2HB ₂	320	30	275	11.6	0.39	0.53
Ganaraska	2HD ₂	94	32	133	19.2	0.60	0.51
Trent	2HK ₂	3,514	33	3,070	11.9	0.36	0.43
Ottawa	2LB ₁	55,560	33	67,400	16.4	0.50	0.40
St. Lawrence	2MB ₅	298,160	32	240,900	11.0	0.33	0.27
Ottawa & St. Lawrence		353,720	32	308,300	11.8	0.37	

* Values based on 10-year period. Some values include supplemental data from other gauging stations.

TABLE 3.

MANAGEABLE WATER RESOURCES WITHIN GREAT LAKES- UPPER ST. LAWRENCE AND OTTAWA BASINS

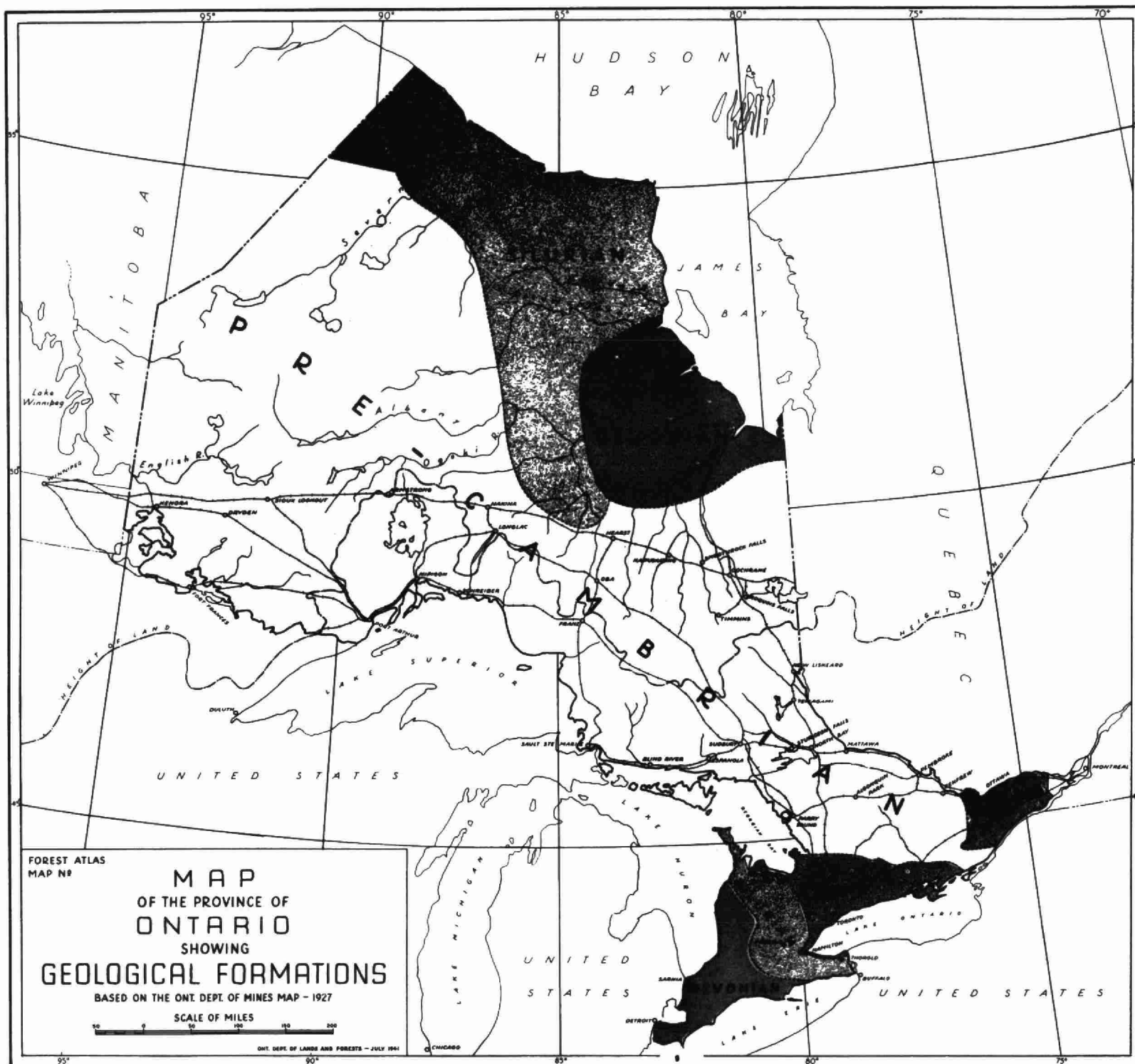
<u>Drainage Basin</u>	<u>MEAN ANNUAL RUN-OFF</u>		<u>Dependable flow corrected for flood & storage factors</u>	<u>Dependable flow available for withdrawal (allowing for waste dilution and wildlife factors)</u>
	<u>Entire Basin</u>	<u>Inland Ontario</u>		
			(1) x 0.50	(2) x 0.50
	(1)		(2)	(3)
<u>GREAT LAKES -</u>				
<u>UPPER ST. LAWRENCE^a</u>				
in inches	11.0	16.3	8.2	4.1
in cfs	240,900	105,000*	52,500	26,000
in mgd	130,000	56,500	28,000	14,000
<u>OTTAWA^b</u>				
in inches	16.4	16.4	8.2	4.1
in cfs	67,400	23,300**	11,600	5,800
in mgd	36,200	12,500	6,300	3,100
TOTAL in mgd	166,200	69,000	34,300	17,100

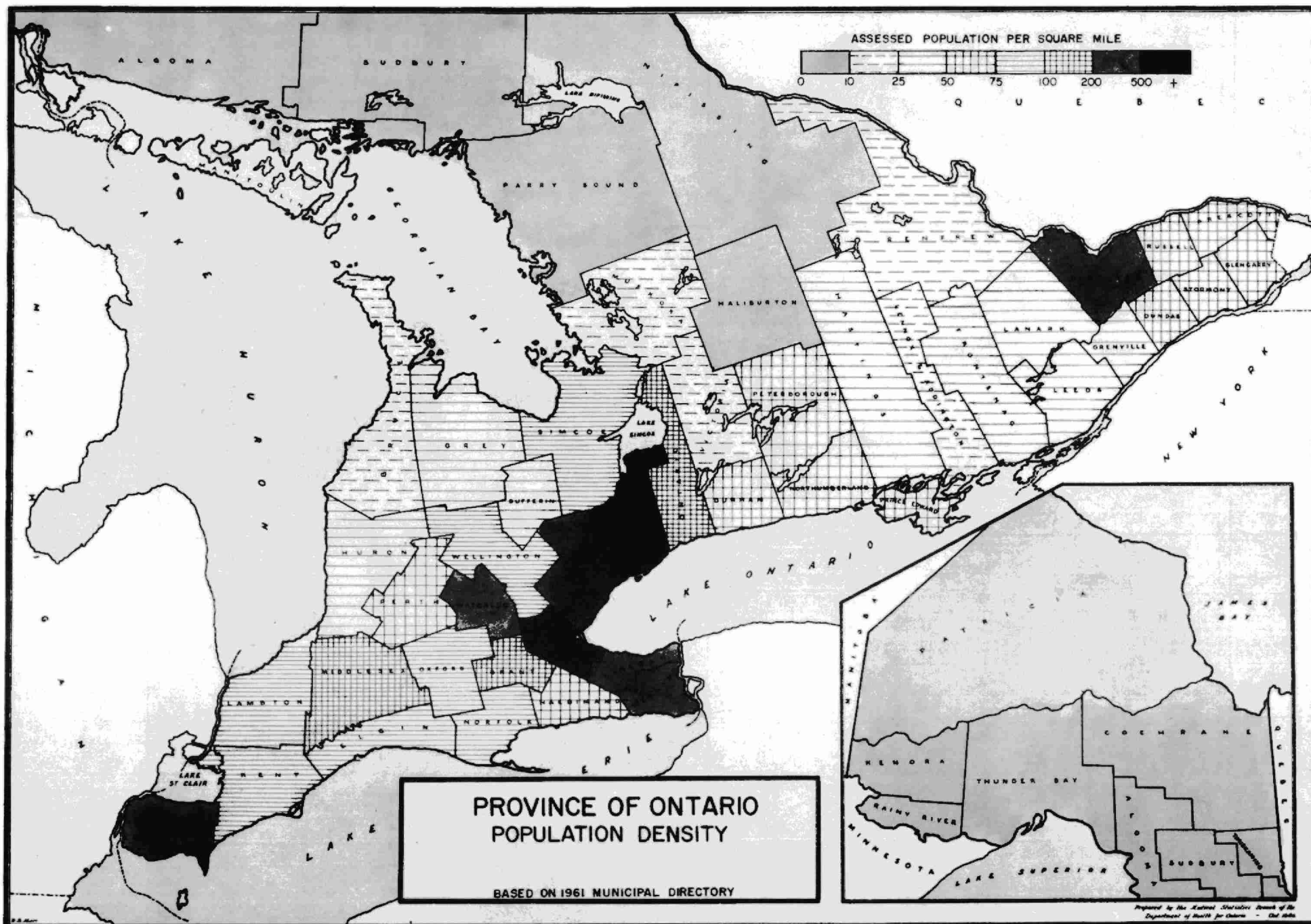
* Based on ratio of land area in
Ontario to land area of entire basin.

** Based on ratio of area of basin in
Ontario to area of entire basin.

a Above Iroquois gauging station

b Above Grenville gauging station





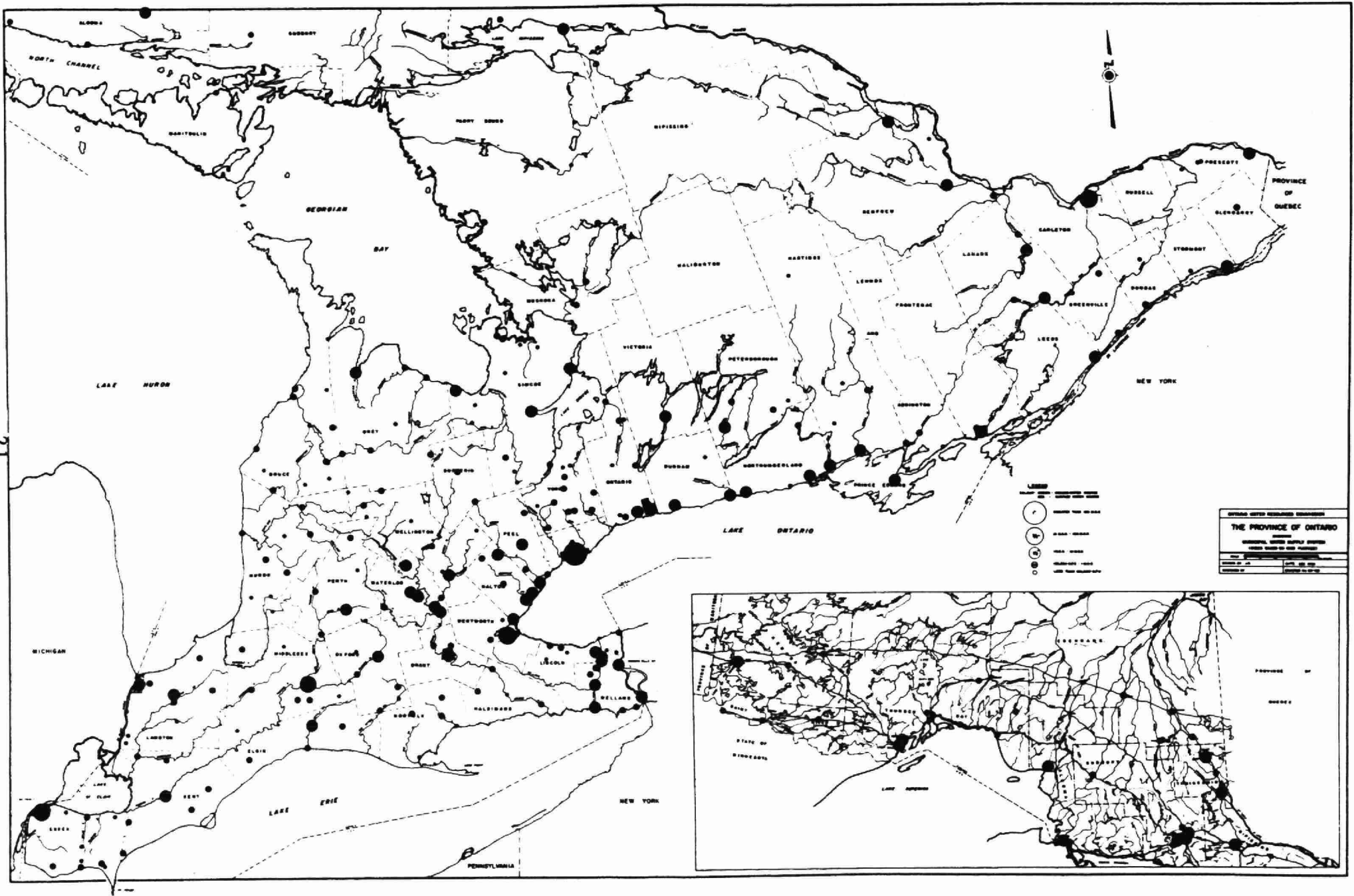


TABLE 4.

MUNICIPAL AND INDUSTRIAL WATER PRODUCTION DATA (1960)
FOR SELECTED COUNTIES

AVERAGE ANNUAL VALUES

COUNTY	POPULATION ^a	MUNICIPAL SUPPLY						PRIVATE INDUSTRIAL SUPPLY	MUNICIPAL SUPPLY AND PRIVATE INDUSTRIAL SUPPLY					
		Production			Dom. ^b %	Use		mgd	Ground		Surface		Total	
		mgd	gpcd	mgd		%	mgd		%	mgd	%	mgd	gpcd	
HALDIMAND	27,036	44	0.2	16.7	1.0	83.3		1.5	14.0	9.2	86.0		395	
CARLETON	332,772	75	24.0	95.6	1.1	4.4		2.5	8.6	24.9	91.4		82	
WATERLOO	171,892	99	5.5	32.4	11.5	67.6		19.7	98.5	0.3	1.5		116	
WELLAND ^d	162,589	166	18.8	69.6	8.2	30.4		0.3	0.2	148.4	99.8		915	
WENTWORTH ^c	333,254	138	31.9	69.2	14.2	30.8		0.6	0.1	514.2	99.9		1545	

a Assessed populations from 1961 Municipal Directory

b Includes commercial use

c 1959 figures

d Approximate figures - industrial water use survey report under preparation

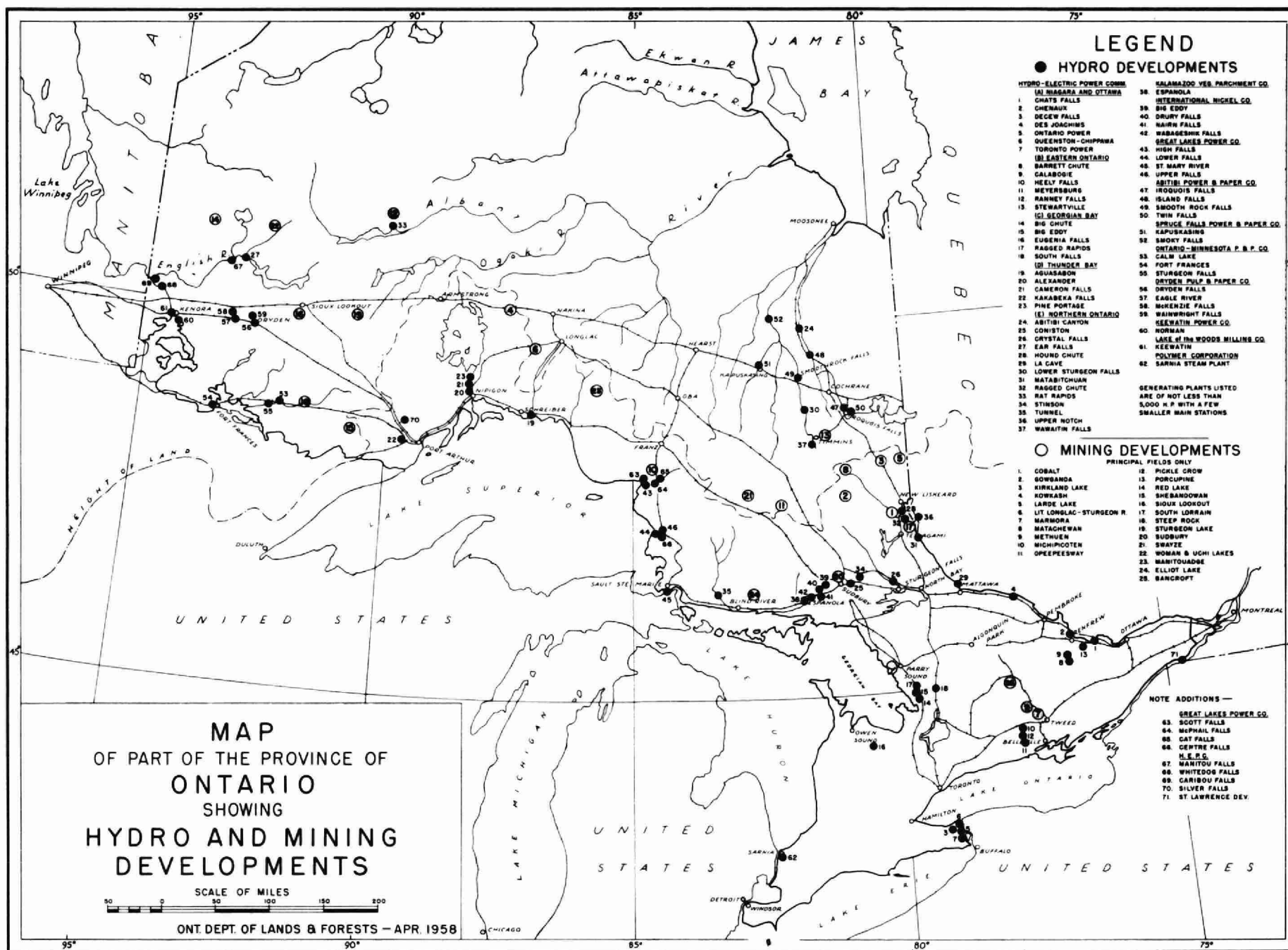
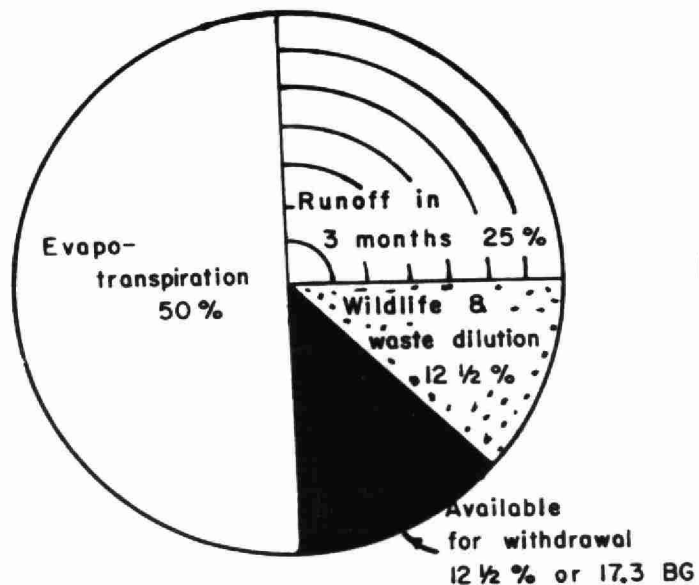


TABLE 5. WATER USE FOR POWER DEVELOPMENT
BY ONTARIO HYDRO-ELECTRIC POWER COMMISSION

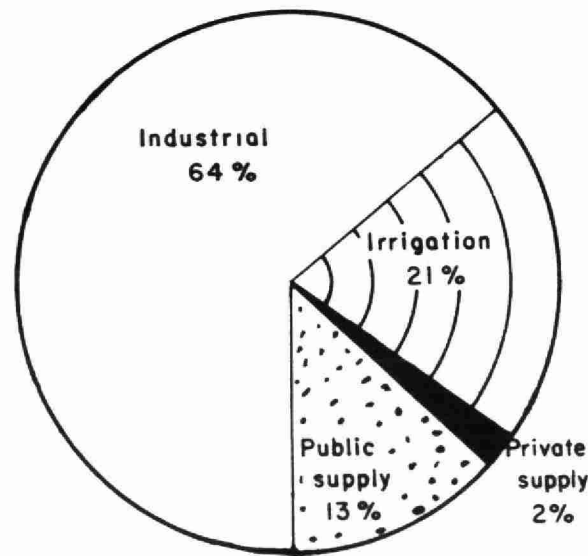
	Average Annual Values cfs
A. THERMAL GENERATING STATIONS	
Present Use	3,120
Anticipated use upon completion of plants under construction	
	1962 - 3,684
	1964 - 5,349
	1966 - 6,349
B. HYDRO GENERATING STATIONS	540,000



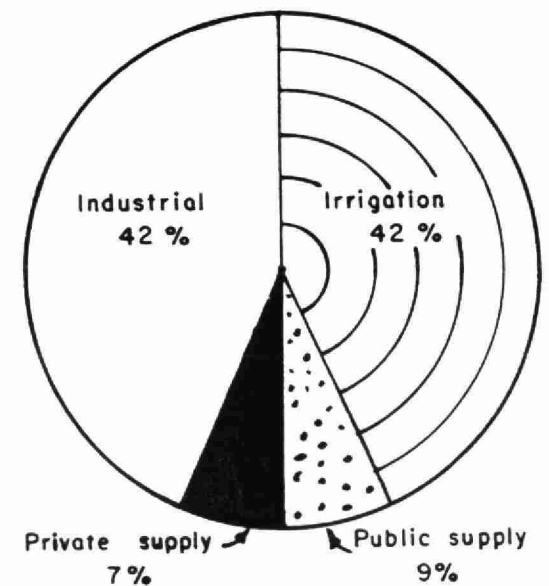
Water Supply on Land Surface of Great Lakes - Upper St. Lawrence and Ottawa Basins in Ontario



Distribution
138 BGD



Withdrawal
4.7 BGD



Consumption
1.1 BGD

DISCUSSION

Professor Keith L. Murphy, McMaster University, Hamilton;

"I am questioning one figure. I would like to go into more detail in regard to the seven or eight percent used for private domestic supply. I realize that it is not your figure. I am wondering if you could indicate just what this might consist of?"

Mr. Snider replied:

"I think that a good proportion of this might be interpreted as caused by transpiration, perhaps, around the home due to lawn watering. Perhaps, where this was not the case, it would be the amount used in the homes and for stock watering, milk production and so on. You are thinking there of an individual well supply or a small supply of that nature."

Mr. W. A. Scott, R. K. Kilborn & Associates, Consulting Engineers;

"I would like to ask Mr. Watt a question regarding run-off. I think it is better if a statistical analysis for a 10-year period on a number of watersheds is made. I was wondering if in this paper in which he mentioned, I think, that run-off varies from 40 to 60 percent, whether several figures occurred for the years in which there was a low rate of rainfall."

Mr. Watt replied:

"The figures were taken for just the last 10 years of published data put out by the Water Resources Branch at Ottawa."

Mr. Scott asked:

"Would the figures of a low precipitation year be included in the average given?"

Mr. Watt replied:

"I would expect that they would be because they certainly contributed to the amount of precipitation falling on the watersheds. We used just the data contained in the past 10 years of record. It would certainly influence the average to have a very low year in the calculation."

Mr. W. L. Rice, Chief of Civil Engineering, Department of Public Works;

In Mr. Watt's very fine paper on the uses being made of our water resources by all interests, little mention was made of water uses in which our Provincial Government has a vital interest. These water uses concern many people in our Province in ways that are not readily realized by the public in general.

The Province of Ontario, through the Department of Public Works, spends about one million dollars per year on the construction and maintenance of dams, particularly in the Muskoka and Parry Sound areas. These dams exist to store water for fish and wild life propagation and protection; recreation purposes such as boating and swimming; aircraft landing areas for forest fire fighting and hydro-electric power generation. Of course, all this water is re-usable, but its proper retention, discharge and conservation is very important to the four uses mentioned, and I would like them recorded in this conference - even though they may be of lesser value than for domestic and industrial purposes.

Mr. Watt:

"Mr. Chairman, I would like to comment on that. We didn't take into consideration the use of water for the purposes that Mr. Rice mentioned. If an estimate were attempted on the amount of used water from these lakes it would add considerably to the amount of water-taking mentioned in our paper."

Mr. Charles Huffman, Federation of Agriculture, Province of Ontario;

"You make mention of permits for well drilling. I would like to ask the cost of these permits and what restrictions we may encounter for the purpose of using water for irrigation purposes."

Mr. Watt:

"No charge is made for these permits to take water. The intention is to try to regulate the withdrawal of water from streams and ground water and to prevent interference between high capacity wells and wells in an area where the supply is limited. It is our purpose, certainly, to try to have such water-taking so regulated that there will be no dry streams caused by the uses that are made of it. The permit program should repair the damage done to them resulting from excessive withdrawals and should make more water available to all users who have a right to it, while, at the same time always leaving some flow in the stream.

Mr. Roy Andrews, Polymer Corporation, Sarnia;

"You mentioned one figure, 540 million gallons a day, consumption by the Ontario Hydro. Do you know the percentage that would actually be consumed?"

Mr. Watt:

"I don't know, but I think it would be very small or almost negligible. This is one use of water which allows it to be used over and over again, but I don't have any figure at all on the amount that would be consumed, if any."

THE POLLUTION CONTROL PROGRAM IN ONTARIO

A. M. Snider, Chairman

Ontario Water Resources Commission



One of the main objectives of this conference is a careful examination of our status in the control of water pollution, or the progress that has been made in the management of water quality. This series of papers and discussions is designed to review this from a number of different viewpoints. Many problems are experienced in the control of waste disposal. There is no alternative to the discharge of effluents into watercourses, and all too frequently this must take place when the flow in the stream is small in comparison with the waste effluent. Our objective must be to so arrange the waste treatment and the outfall that the quality of the stream will not be unduly impaired for downstream riparian users. There is this a great variety of conditions which must be encountered in this entire program. The management of water quality is to ensure the usability of that water.

This is a time for assessment of what has been done or what is planned. It is proposed to set before you information on what the Commission has done in less than five years and to ask your advice on our future program and activities. A brief sketch of the formation of the Commission and the legislation made available to it may be of assistance in this discussion. The Commission was appointed in 1956 following an investigation by a Committee appointed by the Government of the day. It was not until the following year that the framework of the present Ontario Water Resources Commission Act was passed. This provided the authority to proceed on a full scale program. The year 1956 was of necessity spent in field investigations and surveys of local needs, as well as the procedures which might be adopted to meet these requirements. The Act which is now in existence is a combination of the original 1957 enactment supplemented by amendments made each year following.

The program of the Commission involves both water and sewage works, but only the part dealing with sewage or pollution control is to be considered at this time. That constitutes a major item, requiring more effort and considerably more expenditures than water works. The sewage program comprises domestic sewage, industrial wastes, and anything else which may impair the quality of the receiving waters. This is in no way restricted to those wastes which may be injurious to health but is much wider in its application.

Before dealing with what has been done by the Commission it seems desirable to comment on conditions which prevailed at the beginning of this period, and on what the policy of the Commission has been in respect to pollution abatement. In 1956 the province was adversely affected by a number of conditions which were responsible for delays in dealing with pollution control. The depression and the war both hindered the construction of sewage and waste treatment plants. There was public apathy for expenditures on these measures, and many municipalities, faced with capital

expenditures on what the voters considered to be more essential, were inclined to delay action on sewage treatment. The fact that wastes had been discharged for many years into these same waters lessened the incentive for incurring high expenditures. This same situation prevailed generally throughout the world, and it has only been in comparatively recent years that a concentrated attack has been made on pollution control in other countries.

The policy of the Commission from the outset was to concentrate on those problems of greatest importance. Pollution control was in that sphere. The Commission has endeavoured to carry out the directive given to it by the legislation. It has always aimed at clean streams so that these waters may be used for all normal purposes.

In adopting a policy of clean streams for Ontario it was necessary to have a clear objective. The Commission early adopted "Water Quality Objectives" for all streams. These were prepared with two aims in mind, one to make certain that the streams would be protected, the other that these streams could carry away properly treated effluents, as any stream must do in a developed area. These objectives are realistic rather than theoretical. They set up requirements which can be met, and which will result in water that can be satisfactory for normal uses. This does not mean that all waters can be used for drinking purposes without treatment, or that there will be no pollution present. It does connote a standard of quality which will successfully serve the needs of the people of this province. This is our philosophy in stream sanitation and our interpretation of the legislative requirements. The procedures for putting this program into effect must be expected to vary somewhat with circumstances.

OBJECTIVES IN POLLUTION CONTROL

The management of water quality in this province necessitates action on a broad front. If the twin objectives of a clean stream and the carrying of waste effluents are to be served a well prepared course of action is essential. The degree of treatment of these wastes and the points of discharge will need to be determined in each instance especially in relation to the local situation and the uses being made of the waters. It has never been the policy of the Commission to grade or classify each stream or receiving waters, but rather to tailor the action to ensure one minimum standard in all cases.

This Commission's policy requires that all domestic sewage be treated regardless of the local conditions. Either primary, secondary, or in some instances tertiary treatment of the sewage will be necessary. Where the dilution is great as in the rivers of the Great Lakes System primary treatment as the first step has been accepted. This will produce

as acceptable a water after mixing of that effluent as will be the case where a higher degree of treatment is used on a low-flow stream.

This policy also requires that no new sewer systems will be installed unless adequate treatment is provided. In existing sewer systems the program has been to require treatment as rapidly as feasible. At the same time the Commission adopted the procedure generally of refusing to approve of sewer extensions until a program for sewage treatment was accepted.

A similar objective was applied to industrial waste disposal. No new industry might be established without first being provided with the necessary waste treatment facilities. This meant that the plans for waste treatment must be approved by the Commission. This practice has been followed from the outset. Aggressive action was also taken to correct the discharge of inadequately treated industrial wastes, as well as such other wastes as gravel washing, excessive hot water, alkaline or acid wastes, and others which might tend to affect the quality adversely.

In order to advance this program of remedial measures the legislation permitted the Commission to enter into agreements with municipalities to design, build, finance, and operate water and sewage works for them. In this way the credit of the province is used to obtain funds for the municipalities. Where industrial wastes enter the municipal sewers or where the municipality has an obligation to treat these wastes the works would serve a joint purpose and enable the industry to secure these benefits. Generally, industry prefers to have their wastes treated by the municipality rather than to set up and operate their own works. Preliminary treatment at the industry is often required before the wastes can be accepted into the public sewers. Where the wastes are voluminous or high in strength in comparison with sewage it is not attractive for the municipality to accept these.

Thus the policy of the Commission has been to require such treatment of all wastes as local conditions necessitated, and to aid in this program by providing funds and technical assistance. These measures have been made applicable to all parts of the province. The program is a big one, and in some instances considerably more time is needed than in others. The loans and subsidy of the Federal Government now in effect for a year has been of great assistance in expediting sewage works construction. It is now possible to examine what has been done in the province to date as well as to review the work which must yet be undertaken.

PROGRESS TO DATE

Any review of progress must take cognizance of the quality of the wastes, whether treated or raw, and the quality of the receiving waters. Accomplishments or progress can thus be measured in three ways:

- (a) By the construction of waste treatment facilities
- (b) By the measurement of constituents present in waste discharges
- (c) By analyses of receiving waters to measure pollution indices.

These parameters provide means for comparing results over any period of time, and in this instance the last five years is chosen. In doing so it is essential to keep in mind that growth in population and industries is continuing at a rapid rate. If no action had been taken in that interval the results on the streams would have been much worse.

SEWAGE WORKS BUILT

If we use the first of these measuring devices, namely the construction of sewage works, it can be seen that rapid progress has been made. Some guidance in this can be obtained from the certificates of approval issued by the Commission for the construction of water and sewage works. At present this is running at 115 to 120 million dollars a year, and of which over 70% has been for sewage works. The expenditures for these rose from 33 million dollars in 1956 to over 81 millions in 1960. These figures indicate the emphasis now being placed on providing sewerage facilities for the public.

A further analysis of this program is seen in the figures for sewage treatment works put into operation during this five year period and those approved but not yet in operation. In the former class is a total of 110 plants for municipal, private and institutional use. These serve a total population of 1,411,062. The list of plants in progress totals 88 which will serve a population of 1,487,336. If these two groups are combined together, as they should be to reveal the accomplishments of the period, it will be seen that the total number of plants reaches 198 to serve a total population of 2,898,398. This population can be compared with the total of 6.2 millions for the entire province including the rural areas and small urban centres where public sewage works are not immediately feasible. This construction program is clearly a heavy one,

and the benefits to be derived will have far reaching effects on water quality management. The list of 198 sewage plants is divided as follows: municipal 143, private 28, and institutional 24. These figures are most gratifying, but even more so is a changed attitude on the part of the public towards undertaking these projects and shouldering the costs required. This has been brought about by several factors. It is believed the policy adopted by the Commission has been an important one, and added to this must be the very effective contributions made by many organizations concerned with conservation, fish and wild life, recreation, and the general welfare of the province. All have combined to accomplish these most encouraging results.

The appendix to this paper contains the list of places where these works have been constructed or are in progress.

It may be of further interest to observe that in the 143 municipal treatment plants of the list all but 35 are for secondary treatment. Again the emphasis is put on full protection of the watercourses. Where primary treatment is used it is because of discharge into large bodies of water with ample dilution. This list also shows activated sludge or modifications of that process to the number of 57. Trickling filters were used in 3 plants, and lagoons or waste stabilization ponds in 41 instances. This shows a decided trend to this method of treatment in the smaller centres.

A further comparison may be seen in the figures on municipal sewage treatment plants in operation prior to 1956 and those undertaken since that date. The first total was 226 as compared with 143 for the last five years. In the former group was 133 primary treatment works or 60% of the total as against less than 25% for the later plants. Only one lagoon was in use in 1956.

This picture is even more encouraging when it is revealed that 84 municipalities are now considering sewage works and are in various stages of development. These include entirely new works, and additions or enlargements to existing facilities all of which are intended to provide further protection to the receiving waters. It is to be recorded that 28 other municipalities with sewage treatment works require additional facilities. At present there are 18 sewered municipalities with no treatment facilities and 43 unsewered municipalities which appear to be large enough to warrant such programs.

WHAT IS NEEDED IN SEWAGE TREATMENT

In spite of the very great progress in sewage treatment construction it is necessary to point out that a substantial amount of work yet remains to be done. Anyone having experience with municipal programs for sewage works will understand that much time is needed to bring these to completion.

It is necessary to gain the approval of councils, ratepayers, and the Municipal Board. Some have difficult situations in respect to finances and unwillingness of the property owners to accept these burdens if they can be avoided. Sewage treatment costs are not popular with the taxpayer because he seldom sees the direct benefits to be derived. He is more concerned with the construction of sewers which will carry away the sanitary wastes and storm waters. In spite of these factors it can be accepted with some confidence that these situations will be resolved in the near future.

PROGRESS IN INDUSTRIAL WASTE TREATMENT

Corresponding progress has been obtained in the treatment of industrial wastes although the statistics are not so readily obtained. There has been gratifying cooperation on the part of industry in undertaking waste treatment facilities. The policy of the Commission has been to require these works at the same time as the municipality goes forward on treatment of domestic wastes. The program is more difficult for industry because of the variety of wastes and lack of standard or well recognized methods of treatment. Some of the major industries involved in waste treatment problems are oil refineries, pulp and paper, canneries, milk plants, packing plants, chemical industries and others.

In recent years good progress has been made in the treatment of industrial wastes. New methods have been developed and much construction has been undertaken. In oil waste treatment much has been done on prevention of oil losses, and in oxidation of phenolic wastes. Lagoon treatment of organic wastes from milk plants, canneries, and meat processing has been extended. There are now 40 of these units in operation. Similarly, spray irrigation has been applied to a number of wastes, but particularly for milk plants and canneries. A total of 48 such systems is now in use, with nearly all of these being installed in the last five years.

The foregoing activities in waste treatment are one measurement of progress in water quality management. Other parts of the program initiated by the Commission may be cited here to supplement the action on construction.

The laboratory branch of the Commission has done much to support the over all program. The sections on chemistry, bacteriology and biology have all made consistent gains, especially since these new facilities have been opened. In the period under review the number of samples received in the laboratory has risen from less than 6000 in 1956 to an estimated number of nearly 39,000 in 1961, an increase of more than six times in that space. The examination required on these samples now exceeds 110,000 a year. The laboratory has also done much to improve methods of analyses and to utilize to the full the most modern techniques for determining and interpreting water quality.

One of the most useful aids in this program has resulted from the operation of sewage treatment plants by the Commission. In this way there is close supervision over the works built by the Commission and full use is made of the laboratory services, the technical knowledge of personnel, and the experience derived from the operation of many plants. Unless these works are operated at high efficiency the desired results cannot be obtained, and money may be spent to poor advantage. The Commission has also put into practice a course of instruction for all plant operators as an aid for efficiency in these works. The courses are held in this laboratory building.

The financial difficulties of some municipalities in these programs was recognized when the legislation was passed. At the present time the Commission has agreements with 139 municipalities for the construction and financing of 184 water and sewage projects. Over two-thirds of the expenditure of about 74 million dollars is for sewage works.

The program related to industrial wastes has been aided by several activities. The Annual Industrial Waste Conference has served as a forum for the exchange of information on many problems. Similarly, encouragement has been given to industry to organize their plants in regions to better cooperate in the improvement of techniques. Conferences in this laboratory with industry has proven helpful in a joint approach to these problems.

The acceptance of much industrial waste into municipal sewers has facilitated the treatment of these liquids. There has been a trend in this direction in recent years, and when provision is made for preliminary treatment at the industry and financial problems are settled between the two parties this can be a distinct advantage.

The Commission has recognized the importance of research into the many problems on waste disposal, and active steps are being taken to develop a full scale program in this in which there will be coordination of efforts and close cooperation among all parties.

SUMMARY AND CONCLUSIONS

In summary it will be evident from the foregoing that the program followed since the creation of the Commission in 1956 has accomplished a great deal. This has been made possible by the cooperation of many groups. The construction program for sewage and waste treatment has been a successful one, and this will mean a great deal in the protection of our water

resources. This has been supplemented by other activities to create a well-balanced and progressive program. This will be continued until the remaining municipalities and industries are supplied with effective treatment works of adequate capacities. The policy of operating and exercising close supervision over these treatment works will add much to the results to be expected.

The policy of the Commission in carrying out the directives of the Legislature of the Province has been to attack pollution wherever it is found. We can now look forward with confidence to the time when all streams and watercourses will be protected fully against the ravages of pollution. All new pollution has been stopped and existing sources are being progressively brought under control. The assistance of all at this conference will be welcomed in furthering these efforts.

DISCUSSION

Gavin Henderson of the Conservation Council of Ontario remarked Mr. Snider had given a "very interesting and encouraging" report of the Commission's activities, but said he was disappointed not to find any mention in Mr. Snider's remarks or in the conference program on a "very vital aspect of resource management, information and education." He said that at the "Resources for Tomorrow Conference" held recently in Montreal, information and education was rated equally with all the main resources. Government agencies and other informed individuals, Mr. Henderson said, should make every effort to present the facts in understandable form for use by individuals, organizations and the general communication media.

The Commission, he said, had a public relations branch which was doing very efficient work, "but public relations is not public information and public education." The two should be considered entirely separately, and he expressed the thought the OWRC should take a much larger share of its responsibility in this field.

Mr. Snider remarked that education and public information formed an exceedingly important part of OWRC activities. He assured Mr. Henderson the Commission would not forget this aspect of the work and mentioned that there were a great many groups who would be glad to assist in this service.

Dr. A. E. Berry, Commission General Manager, said the OWRC was anxious to disseminate as much information as possible.

THE STATUS OF STREAM SANITATION IN ONTARIO

* * * * *

Dr. A. E. Berry, General Manager
Ontario Water Resources Commission



Since this is a time for taking inventory of what has been accomplished in water quality management and what yet remains to be done it is appropriate to examine the status of stream sanitation. To what extent is the usefulness of these water resources impaired by the discharge of sewage, industrial wastes, or other substances? In the final analysis the important consideration is whether the receiving waters are able to carry away the wastes without deterioration or impairment for domestic consumption, industrial use, agriculture, recreation, fish and wild life. The water resources of the province must serve multiple needs, and the objective is to protect them against wastes so that they can perform these functions.

In the assessment of stream sanitation cognizance must be taken of the different kinds of wastes. It is necessary not only to use testing procedures of many kinds, but to be able to interpret these in the light of local conditions and uses being made of the waters. These results are often confusing to the public. Not infrequently there are complaints that waters are badly polluted when in reality they are of good quality but the interpretation is faulty. Appearance alone can be misleading, and reliance should be placed both on modern laboratory techniques and interpretation by an experienced person.

THE STREAMS OF THE PROVINCE

Ontario is fortunate in having many watercourses and an adequate rainfall. This rainfall finds an outlet in many streams and through the Great Lakes system of rivers and lakes. A major problem is the conservation or distribution of this water to where it is needed. In order to make use of the water in all areas its quality must be closely guarded.

The watercourses of the province have been discussed in a previous paper. They vary widely in size, in the waste outlets, and in carrying capacities for wastes without undue impairment. There is also much variation in the uses made of these waters. All of these factors need examination in an assessment of our present position.

STANDARDS FOR WATER QUALITY

The first question which comes to the fore in examining the status of stream sanitation is the standard of quality required and how is this determined. Should these streams be classified and different grades of quality accepted? The procedure followed in Ontario is in line with that of many other areas of jurisdiction, but it also is not in keeping with what is in use in some places.

The objective of the Commission is a stream quality which will permit the water to serve most normal requirements. There is no classification of streams as practised in New York State and certain other areas. Michigan on the other hand uses no classification but follows a policy similar to that in Ontario. Both measures have support. The objection to classification of streams is that it accepts, with the approval of the regulatory body, a lower quality in some waters than in others, and where the uses of the water are not for what might be considered as a priority class much pollution can be present. The system is also complicated and time consuming in setting up the classifications. In contrast to this is the desire to protect all streams against pollution which will impair their usefulness. The word "stream" is used here to designate all surface watercourses.

The practice followed in Ontario has been to set Objectives for Water Quality. They are the same for all parts of the province. They do not vary much from some of the standards set in classified streams. These objectives are so designed that compliance will permit the use of the waters after treatment for practically all purposes. No one must expect surface waters of a quality that they can be used for drinking or domestic purposes without treatment. The main point is whether the water will respond to normal treatment and then be acceptable. Drinking water supplies must be of a high standard. The requirements for quality of the water as it is delivered to the consumer's tap need not be discussed here. We are concerned with the water in the stream itself.

The "Objectives" adopted by the Commission are quite similar to those of the International Joint Commission. Some of the features of these are that the B.O.D. should not exceed 4 p.p.m., that phenol should not be in excess of 2 p.p.b., that iron should not be more than 0.3 p.p.m., and that the coliform count should not be greater than 2400 per 100 ml. Oil should not be present in quantities to create any objectionable condition, and no substances should be present that will mean an offensive taste or odour. Other qualities are referred to in the Objectives, and it will be apparent that this quality of water will satisfy most normal needs. The Commission feels that if these objectives in quality are attained the watercourses will have fulfilled their primary purpose.

POLLUTANTS IN STREAMS

The pollutants which must find outlets to watercourses are now much more complex than those existing some years ago. When the first survey of the boundary waters by the International Joint Commission was made in 1913 little attention was needed for anything other than domestic sewage. When the survey was repeated in 1946-48 industrial wastes of many kinds occupied a major place. So it is in most streams receiving

the drainage from urban communities in which industrial activities are carried on. Many of these waste products are present in small quantities and the exact effects are not well established either on humans or on aquatic life. Some wastes may travel long distances before they break down. The presence of these wastes in relatively minute quantities calls for special tests such as the carbon filter and bioassays. The interpretation of these results creates difficulties, and it is obvious that if a correct assessment is to be made it should be done only after a full examination of all available data.

SURVEY METHODS

The practice of the Commission has been to carry out field surveys continuously on all major streams and watercourses. It is only in this way that there can be an assessment made of the conditions created by waste effluents. This work is time consuming, and most of it must be done in the summer months. Laboratory facilities must match this high sampling program. Fortunately summer students can be used effectively to work with and supplement the OWRC staff. This has the added advantage of providing a training for these students and offering an opportunity for the Commission to assess their potentials as additions to the technical staff later.

Some information on the survey procedure may be of interest here. A first step is the selection of sampling stations on the stream. It is desirable that these be selected not only to detect conditions in the worst locations, but also that they can be used again in future surveys and thereby provide means for making a comparison of results. The numbering of the sampling stations is related to the mileage from the mouth or outlet of the stream. The number used carries an identifying mark for that stream followed by the mileage. Thus the No. Ni 19.8 would mean a stream shown in the records as Ni and 19.8 would mean that many miles from the mouth. Maps of the watershed are prepared and the sampling points shown on these. The results obtained at different times can then be shown, if desired, in a boxed tabulation on the map or in a card index. It is desirable to have a number of sampling results for each station over a period of time to obtain a true interpretation of conditions. The laboratory is now using the membrane filter to obtain direct readings of coliforms in the sample. It is time-saving and economical.

The samples collected are examined in the Commission laboratory, although some analyses as Dissolved Oxygen may be done in the field. A mobile laboratory, used to advantage in some places, is not available to the Commission. The most common analyses made are coliform counts, B.O.D., dissolved oxygen, and such others as may be considered useful where special industrial wastes are suspected. Bioassays, an examination technique of

comparatively recent application, is most helpful in assessing effects on aquatic life. Thus the science of biology is utilized to increasing advantage in this program. Where small quantities of waste are expected the carbon filter technique is employed. This concentrates the wastes from a large volume of water, about 15 to 20,000 gallons, so that the analyses may be readily performed. The spectrophotometer and many other useful devices and techniques are available in this laboratory to further the program of stream analyses and quality control.

These surveys also include samples from outfalls reaching the streams so that there is an evaluation of the quantity and content of all discharges to these waters. Industrial waste surveys of significant industries add much information to these programs.

Another procedure followed in these programs is to conduct the surveys on a county basis rather than on the watershed. Administratively this has advantages. It is then the practice to follow up on action for all waste discharges. The fact that it is municipal in approach lends support for remedial measures.

STATUS OF STREAMS

From all information collected in these surveys it is possible at this time to examine the status of each stream. In what respect do these watercourses meet the objectives for water quality? Are improvements being made, and when can compliance be expected? This is the information which the Commission must examine continuously. Some of these watercourses are reviewed herewith.

(a) The Great Lakes System

Much of the Great Lakes System has been under examination by the International Joint Commission, and in which the OWRC has been a participant. References for these surveys were made by the two Federal Governments to the International Joint Commission. This work has proceeded since 1946, and it is continuing through periodic reexaminations and sampling. The parts of the boundary included in this covers the distance from Sault Ste. Marie to the outlet of the Niagara River. Requests have been made for including the remainder, and if this is accepted this work can be expected to start soon. A further reference to the International Joint Commission involves the Rainy River and Lake of the Woods. This work is now proceeding.

The condition of the boundary waters included in the International Joint Commission surveys was reported in a publication giving the status at the 1946-48 period. Resurveys have been made periodically, and a brochure,

entitled "Safeguarding Boundary Water Quality" published in 1961 brought this information up to date to the end of 1959. This shows that deficiency in oxygen was not a factor for concern in any area. Phenolic wastes and certain other products of industry were prevalent. Coliform counts varied to a great extent. It is interesting to note that phenols discharged in 1946-48 were reduced from a total of 12,990 lbs. per day to 2,496 lbs. per day in 1959. Cyanides were decreased from 8,620 lbs. per day to 4,358. Coliform counts met the objectives except in those areas below major sewage outfalls. This will continue until the sewage treatment plants are put into operation. The significant areas included Sault Ste. Marie, Sarnia, Windsor and Niagara Falls. The sewage treatment programs here are expected to have an important effect in future surveys.

(b) The Thames River

The Thames River draining an area of much population and industry is subjected to a good deal of pollution at a number of points. This is reflected in the coliform counts and in the B.O.D. figures. The Chatham area containing wastes from the city, industrial plants, and tributary creeks exceeds the objectives both for coliforms and B.O.D., but this should be corrected in the treatment works being undertaken. Similarly the London area adds much inadequately treated sewage, and again the objectives are exceeded. The city is working on a comprehensive plan for adequate treatment of these wastes. Certain other areas of the stream are affected for short distances. It is fortunate that natural purification overcomes these zones of pollution and much of this river fully meets the OWRC objectives.

(c) The Grand River

The Grand River has for many years received much pollution, but it is gratifying to say that this situation is being rapidly dealt with through the construction of secondary treatment plants for all municipalities. Disinfection of the effluents will be used to keep down the coliform counts. Analyses made on samples collected in 1961 showed that in nearly all samples the coliforms were below the objective, and the B.O.D. was satisfactory. With the completion of these sewage works we can look forward to a clean river throughout its length.

(d) The Credit River

The Credit River has been subject to sewage pollution from a number of municipalities and certain industries. These have been nearly all corrected, and modern waste treatment facilities installed. The 1961 survey shows no B.O.D. figures above the objective and only a few instances where the coliform count exceeded the limit. One of these was below the Port Credit sewage works which is to be abandoned in favour of a connection to the Toronto Township plant. Thus a great improvement has been achieved on the Credit River.

(e) The Don and Humber Rivers

Both the Don and Humber Rivers show heavy pollution below major outfalls. They exceed the objectives in both coliforms and B.O.D., but this is to be corrected with the use of trunk sewers to bring these wastes to the waterfront for treatment. It can be expected that these streams will be restored to good quality and available for normal uses.

(f) The Ottawa River

The Ottawa, an interprovincial river, is receiving raw sewage from municipalities and much industrial wastes. This will continue until the treatment works now in progress are completed. Here B.O.D. is not a serious factor because of the large flow, but the treatment of all wastes must be carried out to give the needed protection to this water resource. The creation of the Quebec Water Purification Board will enable a joint approach to this problem.

(g) The Lakehead Area

Surveys of the streams at the Lakehead have shown a good deal of pollution in excess of the objectives. This is being met by the sewage treatment works for both cities and action on the industrial wastes. All look forward to correction of this situation.

(h) The Lakefront - Toronto to Hamilton

The Toronto-Hamilton lakefront must receive large volumes of waste effluents from municipal sewage works and industrial plants. Surveys along this area reveal certain sections in excess of the objectives, but apart from this the analyses in 1961 were favourable. The provision of secondary treatment of sewage and careful control of industrial wastes are expected to bring this fully within the objectives.

(i) The Muskoka Lakes

The recreational areas of the province must have clean waters. An extensive survey of the waters in the Muskoka area in 1961 revealed in practically all areas water of excellent quality. Sources of pollution have been kept under strict control.

(j) The Oxford County Streams

One of the early county surveys was made in Oxford County and all sources of pollution were sought. Appropriate action was taken against the offenders with the result that conditions in these streams are now satisfactory.

(k) Inland Small Streams

One of the difficult problems encountered is the pollution of small streams passing through unsewered communities. Where sanitary sewers are not available the tendency is to connect to storm drains or to discharge wastes into the stream. This creates a complex problem in that many of the buildings do not have sufficient land for a septic tank system, and the cost of public sewers is high for such low populations. The policy in these instances has been to require either a complete severance from the drain or stream or the installation of sewers.

(l) Other Streams

The foregoing are merely some of the streams of the province in which pollution control measures have been proceeding. Many others might be discussed, but those listed will show the program. A great deal of work, including surveys and remedial measures, has been done and is proceeding.

SUMMARY AND CONCLUSIONS

To summarize the status of stream sanitation in Ontario it is necessary to refer to the very large amount of work which has been done in recent years and to the improvements brought about. Sewage treatment works either built or now under construction will have a major effect on the condition of these waters. Industrial waste treatment works are being carried on simultaneously with the sewage plants. While the major portions of the streams of the province meet the requirements of the OWRC objectives the remainder can only reach this when the waste treatment facilities are completed and operated effectively. Storm waters, land drainage, and certain uncontrollable wastes will have some continuing effect, but this should not be excessive or anything to be feared.

DISCUSSION

To a suggestion by Norman E. Sutherland, Polymer Corporation, Sarnia, that if streams weren't classified "you are going to let them run down hill", Dr. Berry said he could see no particular advantage to classification, particularly "if we set an objective that is rigid enough."

"Should no one be interested in Lake Huron until the B.O.D. is four parts per million and the coliform count is 2400," Mr. Sutherland asked.

Dr. Berry remarked that as far as B.O.D., it was not one of the useful measurements. There were others for determining quality. For instance, phenol tests would be quite important in the lake whereas B.O.D. would not be important.

He added that the 2400 coliform count was set so that for drinking purposes water could be treated effectively.

"I don't say there isn't a difference of opinion on classification of streams, but I have never been able to satisfy myself that it has any real advantage," Dr. Berry concluded.

Dr. Gustave Prevost, chairman of the Quebec Water Purification Board, said his Board did not intend to adopt classification in Quebec.

Tuesday, November 21, 1961

Afternoon Session

Laboratory Building

Ontario Water Resources Commission

ALGAE--A GROWING WATER RESOURCE PROBLEM

John Neil

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Ontario Water Resources Commission



In April 1960, the United States Public Health Service convened a seminar entitled, "Algae and Metropolitan Wastes". This is believed to be the first conference relating solely to this subject and is an indication of the awareness that algae and wastes are both related, and a problem.

The fact that algae can be a problem can be illustrated by a few examples. Longfellow poetically described the chain of lakes at Madison, Wisconsin with the beautiful musical names Mendota, Monona, Waubesa and Kegonsa. These lakes have now become the classic example of "Induced Eutrophication" as this artificial enrichment of waters is described by biologists. The lakes at Madison are warm and naturally rich. Sewage effluents are introduced into the second lake in the chain. The first lake which received no waste is rich in plants and algae and while occasional population explosion or "bloom" as this is technically termed does occur, they are not sufficient to limit the usefulness of the water for fishing and swimming or for domestic use. The lake receiving sewage effluent and the two downstream have developed obnoxious, odorous, and unsightly blooms of undesirable species year after year. This continued despite court actions, discussions in both state and federal legislatures and hundreds of tons of algicidal chemicals applied to the lakes. Early in 1959 a nine mile diversion was completed at a cost of several million dollars to carry the wastes to another watercourse appropriately named Badfish Creek. The slow process of natural cleansing is now taking place in the lakes. During the first growing season after the diversion, little improvement in conditions were noted.

Other examples may be found in the literature. In Switzerland a lake called the Zurichsee is formed in two similar basins, one of which received municipal wastes. The section receiving no wastes has maintained its original characters of clear water, low algae populations and desirable fish species. The half receiving wastes produces nuisance blooms of algae and large populations of coarse fish.

Many other examples of lakes such as Lake Zoar Connecticut, Lake Washington Seattle could be cited as published references.

It is not necessary to go beyond Southern Ontario to see similar examples. A stream receiving wastes from a secondary treatment plant five minutes drive from this laboratory, exhibits the characteristic algae condition where enrichment has taken place. A similar algae condition from another river shows another species of algae. If there remains any suspicion that algae do not cause nuisances, examples of the algae accumulations along parts of the Lake Ontario and Lake Erie shoreline should dispel them.

Before the impression is left that all algae are bad, a general description of what algae are, where they live and why they live there, should perhaps be given for those not familiar with the algae branch of the plant kingdom.

Algae are plants just as trees and grass are plants. They are green, they manufacture their food in the form of starches or oil by using the energy of the sunlight and the nutrients they extract from the water. In the classification of plants, they are considered to be the most primitive group and some of the algae forms commonly found in our lakes today are thought to be similar to the first life on earth. They are considered primitive, because each cell is capable of carrying out the complete life history as no specialization has been developed into various tissues such as are found in the higher plants, i.e. stems, roots, leaves, or seeds. There are several thousand different species of algae that live in the waters of Ontario. These range in size from a plant as much as four feet tall down to cells which are so small that they can barely be seen when magnified a thousand times in a microscope. They live in oceans and lakes to the depth to which light penetrates and also live on damp soil and even in combination with fungi to produce the lichens.

Algae are the basis of all life in water, as they are the base of the aquatic food chain. In water it is the algae that form the food of the minute crustaceans and bottom dwelling organisms which are in turn eaten by the minnows and small forage fish. These in turn are eaten by the predator fish such as pickerel and trout. Thus while these species do not feed directly on algae there would be no pickerel or trout if there were no algae. It must be remembered that while algae do create nuisances in certain instances a balanced flora is essential to the productivity of water.

Algae are very specific in their needs. The types that are characteristic of lakes are seldom found in streams and those which populate a lake in summer give way to other forms in winter. Some species can only live in very pure water and others are obligated to polluted situations and even some times to a particular type of pollution.

Natural lake waters can be classified according to their chemical make-up and the algae that develop in each will be closely related to the chemical constituents. For instance hard water drainage lakes produce an abundance of species of diatoms, blue-green algae and some green algae. Soft water drainage lakes normally produce less in quantity and the species of algae are often restricted to a few greens and desmids. Because of the narrow range of environments that each species of algae can adapt to,

any change that is applied to this environment, say through the introduction of pollution, will tend to change both the numbers and the species of algae. Just how great this change will be and whether it will be sufficient to reduce the production of fish, or create water treatment or other nuisance problems, depends on the substance and its quantity in relation to the volume and chemical composition of the receiving water.

The productivity of water is determined by the organic and mineral nutrients on which the algae and subsequent invertebrate and fish populations depend. The basic mineral composition in productive water includes such essential elements in a usable form as calcium, magnesium, carbon, silica, sulphur and iron, as well as a number of trace elements. In certain instances, any of these may be limiting, but generally they occur in excess of the algal requirements. Of all the elements necessary for the building of protoplasm, nitrogen and phosphorous are most often found to be critical for algae. The elimination of either one or both of these is often considered to be the factor which limits the development of an algae population.

From this discussion, it would be expected that any change with respect to physical or chemical conditions in the water would be reflected in the algae population, and this is so. These changes can occur in three ways. (1) By direct toxic action resulting in reduced numbers. (2) By the development of unfavourable physical conditions resulting in reduced numbers, or (3) by promoting the growth of the same or other algal species. While much more toxicological data is needed on the effects of various chemicals on algae, a reasonable prediction can be made as to toxic effects using bioassay techniques and interpreting such information as is available in the literature. Instances have been noted where toxic concentrations particularly of heavy metals have reduced algae populations. As this represents the loss of considerable quantities of a valuable product, economics limits this source of pollution.

The extent of changes brought about by physical suppression due to changes in the environment such as reduction of light penetration in the water through color or turbidity or deposition by particulate matter in the water can also be predicted in a general way. For instance, algae are believed to be productive in water down to about one per cent of the incident light reaching the surface. Thus, if color or turbidity change the normal penetration of light from 50 feet to 10 feet, production would theoretically be reduced by four-fifths. This is an important affect which limits production now in many natural waters and does not need to be augmented by turbidities resulting from gravel washing or erosion from poor farming techniques.

The third way that a change may be brought about is by the stimulation of algae growths. This is by far the most important effect of pollution on algae and may well be the greatest single danger of pollution in our natural waters. As was mentioned previously, algae are plants and as such their quantity of growth might be expected to be related to the nutrient supply in the water. The two elements mentioned as being critical to the production of plant life were nitrogen and phosphorous and it can be readily demonstrated that algae production will be stimulated by the addition of these elements where other conditions were favourable. Sewage and certain industrial wastes carry considerable quantities of these elements and for this reason promote the growth of algae. Conventional methods of sewage treatment are designed to eliminate disease organisms and the nuisances brought about by decomposing organic substances. In our most advanced methods of treating sewage the object is to biologically breakdown the organic substances to stable compound or elemental forms. In so doing the algal nutrients are released in a form immediately available to algae and consequently are commonly seen to stimulate excessive growths of nuisance algal forms.

An expanding human population will continue to increase the nutrients supplied in domestic wastes. There is also the possibility that further changes will occur in the nutrient contained by sewage similar to that which took place with the advent and general use of detergents. This simple change in the living habits of people more than doubled the phosphorous content of sewage.

From these observations it is obvious that the further step of nutrient removal is needed in many places to reduce the discharge of fertilizing substances.

Industries such as fertilizer manufacturing, meat packing, or those using or manufacturing nitrogen or phosphorous compounds are other obvious nutrient sources.

A third and perhaps the most important source of fertility results from drainage from farm lands. The advent and increasing use of commercial fertilizers has added to the fertility of streams. Smith, (1) a biologist with the Fisheries Research Board of Canada has estimated that 10% of the phosphorous put on the land in one drainage basin in Prince Edward Island is lost through discharge to the creek. In this instance, the enrichment is considered beneficial as the increased phosphorous content of the river is related to increased speckled trout production. Enriched water from the heavily fertilized and underdrained farm lands of southwestern Ontario, however, only promotes growth in the plant and algae choked drainage canals and streams, typical of that area.

It is difficult to be precise in a prediction of what increased nutrients will do to any body of water. Life in water is a delicately balanced food chain where the algae forms the food of, or is responsible for, the food of all other life in water. For this reason, any change in the algae population will be reflected right through to the fish that are produced.

Instances have been noted where valuable fish species such as bass and pickerel have been replaced by useless populations of carp and coarse fish in situations where over-fertilization of the water occurs.

Canada is indeed fortunate in having most of its population concentrated along the shores of the Great Lakes where the diluting volumes of clean water are tremendous. There are, however, signs that even in some of the Great Lakes changes have occurred in the chemical composition and perhaps the algae, bottom fauna and fish life. Beeton (2) in a paper entitled Environmental Changes in Lake Erie has collected such chemical, biological and physical data as are available from the past sixty years. This data indicates changes in all three categories particularly in the western basin. Because of the sketchy nature of the original work exact comparisons cannot be made but those changes indicated, particularly biological ones, suggest a degradation of the quality of production. For example, a shift has occurred towards less desirable bottom fauna for fish food production and less desirable species of fish. Total poundage has not decreased but dominant populations of white fish and blue and yellow pickerel have now been replaced by a less desirable perch-smelt association.

While the diluting volumes may be considered very large, the population using these lakes for waste disposal is also very large. An example of the absorptive requirement might be illustrated using Lake Erie. The area of Lake Erie is approximately six million acres. The population whose wastes reach Lake Erie is in the neighbourhood of six million people, so that the lake is required to assimilate the waste to one person for every acre of surface. This figure would be approximately doubled when the industrial waste load is added. The western basin receives most of the waste so that this shallow fraction has a combined sewage and industrial loading of perhaps ten persons per acre.

Gross changes in water caused by the addition of sewage or other fertilizing effluents are readily apparent to the biologist examining the algal flora. The number and species of algae readily reflect any gross pollution in the water and any qualified biologist can typify the type of water by the algae it contains. Our clean water lakes normally support a varied population of diatoms and a few green and blue-green species. As organic enrichment takes place a trend towards fewer species of algae and increased numbers are noted. Under extreme conditions of pollution such as is found in oxidation ponds, only one species will be present at any one time but this occurs in tremendous numbers. For example, it

is not uncommon to find as many as 5,000 cells of a green algae, called Chlorella in a single drop of water from an oxidation pond in summer time.

It is not correct to leave the impression that the fertilization of water is undesirable. There are many relatively poor waters whose productivity can be enhanced by fertilization. Indeed, artificial fertilization has been used to stimulate fish production in some management programme. It is probable that fish production would be enhanced in the upper Great Lakes if fertilization from a source such as sewage could be evenly distributed over the total area.

The fact that artificial enrichment is a growing problem has only recently been recognized. The relationships between algae and nutrients in the water and the other factors which control the numbers and species of algae in water are not well understood. The tools available to people studying algae are not well developed and more exact procedures are required. Quantitative estimates of algae populations are normally made by the time consuming procedures of counting and identifying under the microscope. Because of natural factors affecting the population any good estimate of the population can only be made from large numbers of samples taken at frequent intervals over a long period of time. Chandler and Weeks (3) reporting on a two year algae investigation of a limited area of Lake Erie stated, "Until a greater knowledge of the extent of the annual variations is acquired, any attempt to generalize on the basis of observations limited to one season or even one complete year will have little meaning." This is a very time-consuming and expensive procedure.

A second area where further knowledge is necessary is for information on the factors which select and promote the growth of algal species. In this way, some understanding and perhaps control of undesirable species may be achieved. Better chemical methods capable of determining exact quantities of both organic and inorganic substances utilized by the algae is also necessary. A fourth item requiring further research is into means of chemical control of algae populations. The algicides presently available are generally broad spectrum killing all algae species and sometimes fish and other life as well. Specific poisons capable of killing only undesirable species will certainly be necessary in the future though this is no solution in the overall management of algae and other plant and animal populations.

From the previous discussion on the debits in our knowledge it can be readily visualized that this is a very large problem not just for the Water Resources Commission or other Provincial Government agencies, but one that must be tackled on a very broad and fundamental basis.

I have discussed a number of biological requirements but there are some engineering aspects which must also be considered in the control of any future algae problems. Firstly, where nuisances are directly related to municipal wastes the obvious solution is to remove the nutrients at the source. At the present time, there is no feasible economical means of doing this. There is, however, an active research programme presently going on in this field with studies on chemical precipitation, ion exchange and biological concentration as possible means of nutrient removal. When a feasible means has been developed, a considerable expense will be entailed in the capital equipment and operating costs. The financing for this will be a problem in itself as one can picture the difficulty of convincing an alderman to vote the expenditure of millions of dollars for tertiary treatment because the quantity of Aphanizomenon flos-aqua is increasing in the receiving water.

A second engineering aspect and probably the best tool available for reducing algae pollution is in the long-range planning for area sewage and industrial waste treatment and for the discharge to suitable receiving waters. In this way the wastes of many industries and municipalities can be collected for efficient treatment and discharged in a manner calculated to create the least nuisance. Metropolitan Toronto has made a large step in this direction by closing nineteen overloaded and inefficient treatment plants that discharged to unsuitable streams and constructing four large and efficient plants disposing directly to Lake Ontario.

The Ontario Water Resources Commission is unique in perhaps the world in that it is better able to implement this long range area planning than other control agencies. Problems that inevitably arise from petty municipal jealousies and poor judgment can be rationally resolved under the authority of this act. Some joint schemes are now in operation that the Commission have constructed and are operating, but the need for more is apparent.

In summary it should be pointed out that a number of agencies are working directly and indirectly, particularly in the Great Lakes on matters relating to water quality and productivity. For example, the Great Lakes Institute of the University of Toronto, has undertaken an ambitious research programme into many scientific aspects and water chemistry and algae studies are prominent in their program. The OWRC is conducting an increasing number of surveys. With increases in our staff, it is hoped to train water works operators to do regular algae counts. The value of such information over a period of years is readily apparent for assessing changes in algae species and populations. The Ontario Department of Lands

and Forests, the Fisheries Research Board of Canada and U.S. State and Federal agencies all have biologists working on problems and collecting basic data that is of value in assessing changes.

There is, however, a great need for research in this field as it is the opinion of the author that 'Induced Eutrophication', 'Artificial Enrichment', or call it what you may, with its effect on algae and consequently all other life in water, is the greatest threat of pollution today.

DISCUSSION

Question:

Is foaming necessary for the effective cleaning of clothes by detergents and if not, couldn't federal legislation be enacted to require companies to do away with this property?

Answer:

Detergents as they are presently formulated produce foam as part of their washing action. The non-foaming types presently on the market simply have a foam suppressor in them, but when diluted as in sewage, will foam in a similar fashion as the others. A considerable amount of research is presently being undertaken to develop an economical detergent product which will readily break down in sewage treatment facilities. In order to replace the present detergent product a type must be developed that is equally effective in washing and competitive in price.

Question:

Do the same factors that encourage the growth of algae also encourage the growth of weeds on the bottom of the stream or watercourse?

Answer:

There is a considerable competition between plants and algae for the available nutrients. Usually one or the other groups predominate. In addition to the competition for nutrients, dense growths of algae may limit the production of rooted aquatic plants by reducing light penetration.

Question:

What is the relationship between algae and oxygen?

Answer:

Algae are green plants and for their growth and development they utilize the energy provided by the sunlight, utilize nutrients taken from the water, remove carbon dioxide from the water and give out oxygen. During the hours of daylight, therefore, algae provide oxygen to the water. At night the reverse process takes place where the algae consume oxygen and give off carbon dioxide. Under normal growing conditions the algae produce much more oxygen than they consume at night and thus are useful in maintaining an aerobic condition in natural waters.

Question:

Are the algae in lagoons effective in growing phosphate?

Answer:

When algae grow one of the nutrients that they extract from the water is phosphorous. These algae either flow out with the effluent or sink to the bottom where they decompose and release the phosphorous which will then also flow out as a solution. Studies are presently underway to develop means of harvesting the algae so that this nutrient substance can be reduced. Unfortunately the algae that grow in oxidation ponds are very minute and there is a technical problem in trying to screen or remove in some way these algae from the water.

Mr. W. L. Rice:

A problem exists in Rondeau Bay on the shore of Lake Erie. Apparently an ever increasing quantity of fertilizer residue is flowing into the Bay from the many farm drains and streams in the locality. This residue and/or other nutrients seems to have a very definite stimulating effect on algae growth in the water and weed growth along the bottom of the Bay. The weed growth has been so unbelievably heavy during the past few years that ducks have been seen to be practically walking on the weeds instead of swimming in the water. Last summer a Department of Lands & Forests Beaver Aircraft, equipped with floats, had difficulty in landing on the Bay because of the danger of the weeds fouling the pontoons and rudders of the plane. The former Premier, Hon. Leslie Frost was one of the passengers, and immediately requested an investigation into ways and means of removing these weeds and for preventing such heavy growth.

To date, no method has been evolved for preventing weed growth. A small floating cutting machine has been in use by the Department of Lands & Forests, but is very limited in its usefulness. Perhaps in Lake Erie there is a definite relationship between pollution of the water by domestic and industrial wastes and farm fertilizer residues, and the heavy growth of algae and weeds and the apparent drastic change in the species of fish being caught.

The Department of Public Works would welcome some suggestions for the prevention of excessive weed growth in Rondeau Bay, which may rightfully be attributed to pollution.

Mr. F. R. Hore, Department of Engineering Science, O.A.C.;

Mr. Neil laid considerable stress on the importance of phosphorus as a nutrient responsible for the growth of algae and on run-off from agricultural land as one of the possible sources of this element.

To shed some light on this topic, I checked on some research data from Illinois where tile drain effluent was measured and chemically analysed for the period 1941-47. The following results are in lbs./acre/year:

<u>Nitrogen</u>	<u>Calcium</u>	<u>Magnesium</u>	<u>Potassium</u>	<u>Phosphorus</u>
2.9	14.0	6.3	0.2	Traces too small to measure

These results show that very little phosphorus is contained in tile drainage water.

NUCLEAR CONTAMINATION OF WATER SUPPLIES

Dennis P. Caplice, Industrial Waste Branch

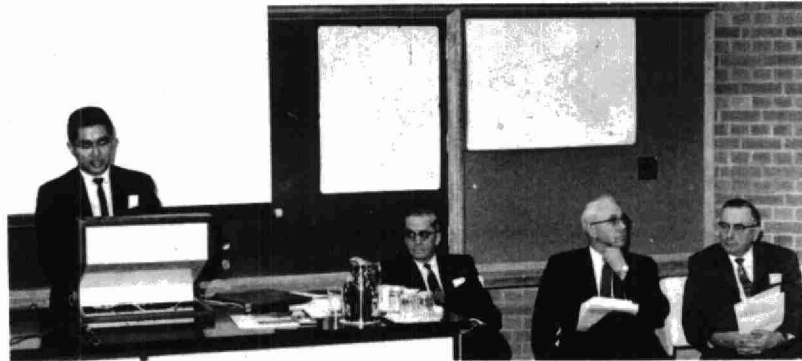
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presented by

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INTRODUCTION

At the present time, the sanitation of our environment encompasses many fields of activity and the one of primary concern to the group here, is the water pollution. It is obvious that there are many phases of these activities which require specialized training outside the scope of the engineer engaged in all the problems of water quality management. Many phases of the atomic energy industry come into this category. There are many environmental problems regarding radiation, and these problems are amenable to control, but we must have the necessary training and experience in the public health aspects of nuclear science and technology. The scope of this paper is limited to the radioactive contamination of water supplies and this no doubt, is the aspect which is of prime interest to the group here today.

RADIOACTIVITY

The term radioactivity may not mean much to some of us, other than the fact that it does exist. The classical picture of an atom consists of a central nucleus, about which rotates a number of electrons in specific orbits, similar to the rotation of planets about the earth's sun. The nucleus is made up of relatively massive neutrons and protons. The proton carries a positive electrostatic charge whereas the neutron has no charge.

Certain atoms are radioactive; that is, they have nuclei which are unstable, in the sense that the physical forces within the nuclei, are not well balanced. In an effort to achieve a balanced internal force condition, nuclei emit an energetic particle (alpha or beta) or a pulse of energy (gamma radiation) or both. This process is radioactive decay, or radioactivity.

The rate at which a radioactive element disintegrates or decays is a true unimolecular reaction and is found by observing the activity of a given sample over a period of time and plotting a graph of time versus activity. The time required for one-half of a given quantity of a radioactive element to disintegrate into a new element is defined as its half-life. For example, it takes 1590 years for half of a given quantity of radium to change into radon. In another 1590 years, half of the remainder will have disintegrated, leaving one-quarter of the original amount. The half-life of radium is said to be 1590 years.

Over forty kinds of atoms are known that display the property of natural radioactivity, and most of these have atomic weights greater than 200. The heavy metal radioactive elements fall into three series: uranium, thorium, and actinium. For example, the uranium series has U-238 as its parent substance and after fourteen successive transformations have occurred, the end product is a stable form of lead, Pb-206.

RADIOACTIVITY AND HEALTH

What is the importance of nuclear radiation to the water supply field? This can be answered very simply, and that is: Ionizing radiation is harmful to man. Radiation is a form of energy, and if this energy is absorbed by a tissue in the human body, injury can occur.

Everyone knows what happens when high-energy projectiles, such as bullets, strike living tissue. Cells are torn apart or injured, along the path of the missile, until it loses its energy and comes to rest.

Radiation produces a similar effect, but the radiating particles are so minute, that they do not dislocate masses as large as cells. Instead, they react with the individual atoms and molecules that make up the tissue. Along their paths, the nuclear particles knock electrons out of their orbit and these fly off to cause further damage. The process of ejecting electrons from their atomic orbits is known as ionization. The number of ionizations caused by a radiation per unit of path length is known as its specific ionization. Specific ionization is the major factor in judging the relative biologic effect of various types of nuclear radiation.

To date, approximately thirty different nuclear particles have been identified. Of these, only three are of interest to persons engaged in the water supply field: alpha particles, beta particles and gamma rays.

Alpha particles are actually identical to energetic helium nuclei. They are relatively large in mass, and possess a positive electric charge of two. Because of their size and charge, alpha particles have a high specific ionization, that is, they dissipate energy rapidly over a short range.

Beta particles are high-velocity electrons. They are considerably lighter in weight than alpha particles, and carry a charge of minus one. They have a moderate specific ionization and penetrating power.

Unlike the particulate alpha and beta particles, gamma rays are electro-magnetic waves, similar to light and radio waves. They are also quite similar to X-rays, except that they originate in the nucleus. This wave nature results in a very low specific ionization, but make gamma rays very penetrating and a very serious external hazard. The "roentgen" is a unit of measure of the ionization or dose caused by gamma rays.

SOURCES OF RADIOACTIVE CONTAMINANTS

Wastes from the atomic energy industry are gaseous, liquid or solid, and occur in any phase of the industry from the mining of the uranium ore, to the ultimate use of a specific radioisotope in industry, research, agriculture, or medicine. These wastes differ from those with which we have been concerned in the past, because they are radioactive.

The problems of liquid radioactive wastes are generally considered under three headings: low, intermediate and high level wastes. Low level wastes are those which, if decontaminated by a factor of 100 to 1000, would approach permissible limits for human exposure. The range of their activity would be from

10^{-4} to 10^{-3} microcuries per millilitre. (NOTE: A curie is a unit of radioactivity equal to 3.7×10^{10} disintegrations per second and a micromicrocurie equals approximately two disintegrations per minute). It is these low level wastes which are of primary concern to the sanitary engineer, as they are eventually dispersed into the natural water systems and may affect public water supplies.

The initial refining of uranium-bearing ores is a very important source of low level radioactive waste. Raw ore from nearby mines is received at the mill for initial processing, in which the uranium is separated and concentrated. The process steps include crushing and grinding, washing, and treating by several chemical methods. The final product is uranium salts. In this form, uranium is shipped to other installations for further processing and refining, and final use.

Wastes from the ore processing may include waste waters, sand and waste solids and various process liquors. Customarily, these liquid wastes are stored in "tailings" ponds or lagoons, where the volume of waste is reduced by evaporation and seepage. These tailings ponds are usually located at the edge of a stream, and wastes to the stream include seepage as well as certain direct discharges. In Ontario, we have two areas where uranium mill wastes are presenting some problems. The quantities involved and the widespread nature of the problem indicates the need for careful control of waste discharges from uranium mills. In Ontario, surveys have, and are being carried out in the areas where uranium mills or nuclear power plants operate. The purposes of these surveys can be said to be twofold.

1. To determine by extensive water sampling, the natural levels of radioactivity in area surface waters not subject to prior pollution by radioactive contaminants, and to compare the results obtained with those for surface waters receiving contaminants from local industrial operations. This is necessary to determine the extent and significance of any radioactive water pollution.

2. To appraise the waste disposal facilities of the industries which discharge low levels of radioactivity in their waste. Where feasible, monitoring programmes in which composite samples are taken on a daily or weekly basis at specifically chosen locations are put into operation. This practice will undoubtedly grow in the future.

I might also add that with regard to the CANDU reactor near Kincardine, the Great Lakes Institute is studying the physical, chemical biological and radioactive conditions existing in Lake Huron around Douglas Point for a three year period before the reactor is put into operation.

In subsequent years, the Institute will systematically sample water, biota (including commercial fisheries catch) and bottom sediments, for background radioactivity determinations by the Environmental Research Branch of the Atomic Energy of Canada Limited.

Nuclear reactors for power and other purposes represent a potentially great source of radioactive waste material. Aside from atomic weapons, which are a special application of the fission process, there are various types of reactors including experimental research reactors, reactors to produce radioactive materials for industrial, medical and research purposes, and reactors for propulsion of ships. Probably the most important peaceful application of nuclear fission will be power production for civilian use. A full-scale power reactor is being planned for Ontario and will be located on the shores of Lake Huron.

Adequate cooling of these reactors is necessary to prevent mechanical failure of the reactor. In many cases water will be the ultimate coolant and in some cases it may be the primary coolant. There are two ways in which the water coolant may become contaminated. Despite pretreatment, the water may contain impurities such as traces of metal and small quantities of corrosion products, picked up in the circulation system. In passing intimately through the reactor core, the water will become heavily bombarded by neutrons, which "activate" stable atoms upon collision with and absorption by them. Some of the impurities in the coolant will thus be made radioactive through induced radioactivity. The water may also be contaminated due to rupture or failure of a fuel element in the reactor core.

Radioisotopes have a widespread use in research, medicine and industry. For example, Cobalt-60 has been used for the detection of flaws in welds for the determination of the thickness of coatings and materials and for therapy treatment; Barium-140 has been used for detecting changes in the grade of petroleum oil pumped through a common pipeline; Phosphorous-32 is being used as a tracer in agricultural plant studies. Without a doubt, the use of radioisotopes will increase and the potential hazard of a careless or accidental discharge to a water supply will always be present.

As a result of nuclear testing, fallout is an important source of radioactive contamination of surface waters. The problem would exist in the future in an exaggerated form as a result of nuclear war. Most of the contamination would occur as a result of fallout, downwind from the point of detonation. This fallout could contaminate watercourses by direct contact, or could be washed in as a result of rain or other form of precipitation.

Fallout generally consists of fission particles, induced radioisotopes and unfissioned nuclear material. These radioactive substances are trapped or fused in dirt and debris swept into the mushroom clouds of a nuclear explosion. Nuclear fission results from the bombarding of certain heavy atom nuclei with neutrons, with the formation of two or more lighter elements and the release of neutrons and energy.

Another source of radioactivity which should be considered is natural radioactivity. Radioactivity exists everywhere in the environment. It is found naturally in soils. All natural waters contain some dissolved radioactive materials, that are leached from the soil, and this material appears in water as background radioactivity. Natural radiation in the form of cosmic rays has been present since the beginning of mankind. The radioactive

background in natural waters is in the 10^{-9} to 10^{-6} microcuries per millilitre range. This background is gradually being raised by atomic detonations, and fluctuates from day to day because of many natural factors.

TABLE 1

Sources and Magnitude of Background radiations

SOURCE	MAGNITUDE MICROCURIES/ml.	REMARKS
Cosmic radiation		About 70% of total background at sea level is due to cosmic radiation
Naturally occurring radioisotopes		Uranium and Thorium K ⁴⁰ , Rb ⁸⁶ , Sm ¹⁵⁰ , Lu ¹⁷⁶ , Re ¹⁸⁷
Radioactivity of soils and rocks		Uranium 6 ppm by weight Thorium 12 ppm by weight Radium 2×10^{-6} ppm by weight
Radioactivity by air	10^{-10}	Radon concentration by air; generally higher during rainfall.
Radioactivity in fresh water*	$10^{-9} - 10^{-10}$	Varies, with values 10 to 1000 times higher in some springs
Radioactivity in sea water	3.3×10^{-7}	Due primarily to K ⁴⁰ contained in sea water

* Fallout may increase the radioactive contamination of surface water by a factor of up to 1000 to $10^{-6} - 10^{-7}$ microcurie/ml.

MAXIMUM PERMISSIBLE CONCENTRATION (MPC) OF RADIOISOTOPES IN WATER

The Subcommittee on Internal Dose of the National Committee on Radiation Protection has prepared and published considerable information on the MPC of radioisotopes under peacetime or long-term exposure. The MPC concept is an important one, and is a necessary adjunct to any consideration of removal efficiency and therefore should be thoroughly understood by the sanitary engineer and water works official.

Four things must be known:

1. The gross initial concentration of radioactive materials in the water.
2. The composition of the main nuclear constituents, and this requires a radiochemical analysis of the water.
3. The MPC value established, for the radioisotopes in question, so that the true removal or efficiency of the process or processes under investigation can be evaluated.
4. The remaining or residual activity for determining whether or not the treatment process will actually meet the concentrations delineated by the MPC analysis.

For example: An unknown mixture of radioisotopes contains a gross beta concentration of 10^{-3} microcuries per millilitre. This value is 10,000 times higher than the established MPC value of 10^{-7} microcuries per millilitre for an unknown mixture of radioisotopes.

To reduce the activity to the 10^{-7} microcuries per millilitre level, it would be necessary to provide for a removal of 99.99 per cent. Such removal could not be obtained by the conventional water treatment processes, and it would be necessary to resort to more costly procedures such as ion exchange or distillation.

Procedures for identifying the more critical radionuclides in relatively low concentrations have been developed. As with microchemical analysis, the analysis of radioactive mixtures become increasingly difficult, as the number of radioelements increases or as the relative concentrations differ greatly from one element to another. For example, an analysis for strontium-90 requires about twenty times more man-hours than say, the routine water analysis for iron. Nevertheless, it may become necessary to perform radiochemical analysis of liquid wastes, so that the MPC value

associated with the waste can be estimated. Comparison of this MPC value with the activity concentration present, will indicate whether the waste will be hazardous when diluted in the receiving stream, or whether treatment of the waste will be necessary. The MPC concept provides a realistic approach to the evaluation of water decontamination procedures.

DECONTAMINATION OF RADIOACTIVITY IN WATER SUPPLIES

The study of water decontamination procedures has been receiving major emphasis in recent years, and there is no doubt in my mind, that there will be a much keener interest on the part of the general public after all the publicity, which has been given to fallout.

Existing or conventional water treatment techniques or processes, have been evaluated for the removal of radioactive materials from water contaminated with waste solutions. These processes include coagulation, settling and filtration. In addition, studies have been made of the use of clay (as supplemental turbidity and as a primary method for removing radioactive substances from the waste) phosphate coagulation, ion exchange, metallic dusts, softening, and other procedures. The effectiveness of these various methods will be discussed in more detail, later in the paper.

The water decontamination procedures described may be applied to treatment of waters moderately contaminated with radioactive materials. Whether the activity results from warlike or peaceful applications of radioactive materials, the water will probably contain a variety of radioisotopes and therefore the efficiency of the various treatment processes in removing each radioisotope should be known. In some instances a study of waste containing a mixture of radioelements is feasible, as in the use of mixed fission-products waste, for study of emergency measure techniques. In other instances, it is more feasible to study radioisotopes individually.

Many factors must be considered in selecting radioisotopes for study. Of primary concern, is the probability that the radioelement will become a health hazard. From the standpoint of industrial pollution of water supplies, radium is the most important active contaminant from the health point of view, and in the long run should not be allowed to average higher than 10 micromicrocuries per litre of water, (the American Atomic Energy Commission uses a limit of 4 micromicrocuries/litre) where the water is used for a public water supply.

Radioactive materials have several important characteristics, that relate to water treatment processes and it is important that one bears these facts in mind in any discussion on the removal of radioactive contaminants from a water supply.

1. The rate of disintegration of radioisotopes cannot be modified by any physical, chemical, or biological process. In other words, in the treatment processes employed, the radioactive materials are transferred from solution to a solid phase (chemical precipitates, sludges, or soils). The radioactive materials associated with these solids must still be disposed of in a safe manner. The most common practice is to store these concentrated radioactive solids in tanks or to bury the material in approved areas where there is no likelihood of ground water contamination.
2. Chemically, radioactive isotopes react the same as their stable counterparts. Thus, if a process removes the stable elements as in the case of the precipitation of calcium, radiocalcium will be carried down in the same manner. Substances, such as strontium and barium, which are chemically related to calcium are also partly removed by a process designed for the removal of calcium.
3. The amounts of the radioelements presently encountered are exceedingly small, and this can be illustrated by a comparison of the permissible levels of specific elements in the Drinking Water Standards (DWS) and the maximum permissible concentrations indicated for radioisotopes of these elements. (Table 2) for example, the maximum concentration of iron allowed in a water supply before rejection is 0.3 parts per million. In comparison, the maximum permissible concentration of a radioisotope of Iron-55 is 1.8×10^{-6} parts per million. (MPC for Sr-90 is 5×10^{-9} ppm).
4. Since the radioelements are present in such low concentrations, the usual qualitative and quantitative procedures cannot be used in their identification. However, because these materials are radioactive, this characteristic may be utilized to detect, measure and identify them. As was previously mentioned in this paper, in order to determine specific radioisotopes, radiochemical and electronic instrumentation procedures must be employed.

I am sure that you can well realize some of the problems that are involved.

Now, most of you are quite familiar with the conventional water treatment processes of coagulation, settling, filtration and disinfection. In addition, there are auxiliary processes such as aeration, softening and iron and manganese removal. A considerable amount of work, mostly on the laboratory and pilot plant scale, has been carried out and a resume of some of results obtained are in order.

In the treatment of surface waters, coagulation is usually the first process carried out and it involves the formation of chemical flocs that absorb, entrap or otherwise bring together suspended matter, particularly suspended matter that is colloidal. The addition of coagulating chemicals will also result in precipitation of some of the soluble constituents in the waste as metal hydroxides; generally, hydroxides of aluminum or iron since alum and iron salts are the most commonly used coagulants.

Combined with settling, coagulation is effective for removal of radioisotopes whose valence is 3, 4, 5 and among these are scandium, niobium and chromium. A number of variables effect the efficiency of coagulation in the removal of radioactive contaminants and among these are pH, turbidity, the specific radioisotope and the addition of a supplementary compound. Generally, a high pH, the presence of small amounts of activated carbon will increase the percentage removal. The addition of excess coagulant will not necessarily improve removal of the contaminant.

A study made in a number of cities in the states showed that municipal treatment plants removed between 10 and 85 percent of the stable strontium present by iron or alum coagulation. While a great number of factors must be considered, coagulation is not very effective for removal of radioactive materials from water.

Filtration is generally the next step after coagulation in the treatment of surface waters. Municipal rapid sand filters, in themselves, are not too effective, and their major function is to remove radioactivity previously incorporated in floc particles. The amount of radioactivity removed by filtration and coagulation varies, and depends on the nature of the material. For example, materials which are present in the colloidal state are removed by the filters but other materials (and strontium-90 is one of these) which are present in true solution are not affected by passage through sand filters.

Softening with lime and soda ash has been studied and, under proper conditions, effective removals of radioisotopes such as strontium have been obtained. An excess of both lime and soda ash gave the best removals. Since strontium and calcium belong to the same group of elements, the strontium-90 present is removed by co-precipitation with calcium carbonate. Under the optimum conditions, the lime-soda softening process is capable of removing in excess of 99 percent of the strontium. From the standpoint of emergency use, the process would not be generally applicable, because the majority of municipalities are not equipped for softening.

While it is not a conventional water treatment process, the use of ion-exchange treatment should be mentioned, because it is a very efficient method in removing radioactive materials. In mixed beds containing both anion and cation resins, removals in excess of 99.99 percent have been reported. The effectiveness of ion-exchange units is dependent entirely upon the chemical composition of the water under treatment. In general, removal of radioactive materials parallels hardness removal, although some of the radioactive material may be removed, even after the ion-exchanger's hardness removal capacity has been exhausted.

Some modified techniques of water treatment have been studied and these deserve mention as they are capable of removing a relatively high percentage of some radioactive materials. These methods include phosphate coagulation, electrodialysis and the use of metallic dusts and clays as slurries.

Distillation should also be mentioned here. Although it is not a generally accepted municipal water treatment process, there are some saline water conversion units which utilize the distillation process. At the present time, it is the most effective process for concentrating radioactive materials. Under the proper conditions, it is possible to produce a condensate of very low activity and therefore, high removal efficiencies are possible. However, the costs are prohibitive and its use would only be feasible under emergency conditions.

Speaking of emergencies, it might be worthwhile to mention some of the steps which one should take if the source of water supply becomes so concentrated in radioactive materials that it cannot be made safe by the usual water treatment methods. First, all householders should be warned that, until further notice, the water supply is unsafe for drinking. They should then be advised to use water in their hot water tanks or canned fruit juices, soft drinks etc., until emergency water supplies have been established. Emergency needs can be met by existing safe groundwater supplies, by water brought in by tank truck or tank car or by use of emergency type field decontamination units. These units, consist usually of ion exchange materials and are effective for treating small quantities of water.

It should be pointed out that with any of these processes described, the radioactive materials removed from the water are not eliminated but are merely concentrated in a solid form and this will create some problems, as suitable storage or disposal facilities will be needed.

It should also be pointed out that the removal of radioactive materials from surface waters starts long before the water reaches the treatment plant. In surface water, the physical process of sedimentation reduces the particulate activity, the extent depending upon turbulence of the stream and size of particles. In addition many silts have ion-exchange capabilities and can reduce the level of soluble activity. Biological processes involving both plants and animals may be effective in reducing the radiochemical concentration. Unfortunately, the benefit of these natural processes is only temporary because the radioactivity is only stored in the stream and not removed.

One other factor which must be mentioned is (in determining criteria for the safe disposal of radioactive wastes test, it is important to consider all means by which the population is exposed to radiation). It has been generally concluded that the effects of radiation exposure are cumulative, and the total exposure of the population is much more significant than the fraction of it associated with one particular source, such as drinking water. An individual may drink slightly contaminated water or milk, eat slightly contaminated food, and breathe slightly contaminated air. Some individuals may during their working hours inhale or ingest somewhat higher amounts of radioactive materials as a result of their occupation in the nuclear industry. It is therefore, the total exposure that has real significance and it is important to examine each source, such as domestic water supply, in the light of total radioactivity intake by man from all local sources. While any individual exposure, such as from drinking water, may be lower than the maximum allowable, the total radiation from all sources may exceed the level of exposure, which is regarded as safe.

The Nuclear Age is here to stay. A great deal has been said about it by persons representing all walks of life, regarding the use and misuse of nuclear energy, but one thing is certain and that is, man must adjust to it, learning to live and work in this new environment. Coping with radioactive contamination of our water supplies is only one of these adjustments.

GLOSSARY OF TERMS *

Activation - The production of radioactive isotopes, for example, by neutron bombardment.

Alpha particle - A helium nucleus emitted in radioactive decay.

Artificial radioactivity - Radioactivity induced in a non-radioactive material by, for example, neutron bombardment.

- Atomic mass unit (a.m.u.) - The unit of mass on the atomic scale, defined as one-sixteenth the mass of $^{16}_0\text{O}$ atom. 1 a.m.u. = 1.65985×10^{-24} gram.
- Atomic number (Z) - The number of protons in the nucleus. Each element has its own characteristic atomic number and these range from 1 (hydrogen) to 102 (nobellium).
- Atomic weight - The mean of the isotopic masses (relative to $^{16}_0\text{O}$ = 16.000) of an element, weighted for their natural abundance.
- Background - The natural level of radiation at any point. In nucleonic instrumentation, the reading obtained on an instrument in the absence of the source to be measured.
- Beta particle - A high velocity electron emitted in radioactive decay.
- Biological half-life - The time taken for an organ to eliminate through biological processes one-half of the quantity of a specified element that has been introduced into it.
- Contamination - The presence in a common substance (e.g. water or air) in the environment, or on a surface, of a harmful amount of radioactivity.
- Cosmic rays - A complex, very penetrating system of radiation incident upon the Earth from outer space.
- Counter - An instrument which records, as a number of certain fraction of the total individual disintegrations occurring in a source of radioactivity during a given time.
- Curie - Unit of radioactivity equal to 3.7×10^{10} disintegrations/second.
- Daughter product - The isotope produced by the radioactive decay of a parent element.

* Radioactive Wastes-Their Treatment and Disposal
John C. Collins, B.Sc., M.S.E., A.M.I.C.E.

GLOSSARY OF TERMS (CONT'D)

- Decontamination factor - Ratio of the activity content of material before treatment to that after treatment.
- Disintegration - Disruption of the nucleus with ejection of an alpha or beta particle.
- Effective half-life - The time taken for the amount of a radioelement, which has been introduced into a specified organ, to diminish to half its initial value by the combined processes of radioactive decay and biological elimination.
- Electron - A fundamental particle with mass 0.00055 atomic mass unit and a single negative charge equal to 4.802×10^{-10} electrostatic unit.
- Element - One of the fundamental chemical substances. Each element has its characteristic atomic number.
- External radiation - Radiation incident upon the body from an external source of radioactivity.
- Fallout - Radioactive material deposited on earth following the explosion of atomic bombs.
- Fission chain reaction - A chain reaction is one in which one or more of the products of the reaction are instrumental in perpetuating that reaction. In a fission chain reaction of neutron reacts with a fissile nuclide to produce fission products and further neutrons which, under suitable conditions, are capable of causing the fission of further fissile nuclei.
- Fission product - An isotope which has resulted from nuclear fission.
- Gamma radiation - Electromagnetic radiation of short wavelength emitted in radioactive decay.
- Geiger counter - A counter operating in the Geiger region.
- Heavy water - Water in which the hydrogen component is present as deuterium; that is, deuterium oxide.

- Internal radiation - Radiation arising from radioactivity incorporated in the tissues of the body which are therefore irradiated by it.
- Ion - Electrically charged atom or groups of atoms.
- Ion exchange - The property possessed by certain materials of exchanging the cations or anions, with which these are charged, for other ions when a solution containing them is brought into contact with the material.
- Ionization - The removal of one or more of the outer electrons from an atom.
- Ionizing radiation - Radiation, either corpuscular (alpha or beta rays, or neutrons) or electromagnetic (gamma rays), which is capable of producing ions in the matter through which it passes.
- Isotope - If two atoms have the same atomic number (Z), but different mass numbers (A), then they are both isotopes of the element whose atomic number is Z .
- Mass number (A) - The number of neutrons and protons in the nucleus. Also the nearest integer to the exact isotopic mass.
- Maximum permissible body burden - The total body content of a radioisotope which, if maintained, will not deliver to any critical organ a dose greater than the maximum permissible.
- Maximum permissible concentration - The concentration of a radioisotope in air, water, milk, etc. which will deliver not more than the maximum permissible does to a critical organ when breathed or consumed at a normal rate.
- Maximum permissible dose - The dose of ionizing radiation accumulated in a specified time, of such magnitude that no bodily injury may be expected to result in the lifetime of the person exposed and no intolerable burden is likely to accrue to society through genetic damage to his descendants.

Maximum permissible level - A term used loosely to refer to the maximum permissible dose-rate of radiation, the maximum permissible concentration of a radioisotope or the maximum permissible degree of contamination of a surface.

Micro - A millionth part of a.....

Micro-micro - A million-millionth part of a

Milli - A thousandth part of a

Neutron - A fundamental uncharged particle of mass 1.008983 atomic mass units.

Nuclear energy - Energy derived from the nucleus by fission or fusion.

Nuclear fission - The splitting of the nucleus of a heavy atom into two fragments of approximately equal mass, generally by neutron bombardment.

Nuclear fusion - The joining of light nuclei to form a heavier one.

Nuclear isomer - Two nuclei with the same atomic number and atomic mass, but in different energy levels are said to be nuclear isomers.

Nuclear reactor - An assembly in which a fission chain reaction is caused to take place in a controlled manner. The essential components of a reactor are a fissile material for fuel, a moderator, a coolant and a neutron absorbent material to act as a control for the neutron flux in the reactor core.

Nucleus - The central core of the atom composed of protons and neutrons.

Particulate activity - Radioactivity due to particulate matter.

Proton - A fundamental particle with a mass of 1.007595 atomic mass units and a single positive charge equal in magnitude to that of the electron. The proton is the nucleus of the normal hydrogen atom.

Rad - The unit of absorbed radiation dose: a dose which results in the absorption of 100 ergs per gram of specified material.

Radiation - The form in which energy may be transferred from one point to another in space. (see Ionizing radiation).

Radioactive half-life - The time required for the number of atoms of a radioactive species to decay to one-half its present value.

Radioelement - A radioactive isotope of an element.

Radionuclide - A radioisotope.

Rem - The quantity of ionizing radiation which has the same specified biological effect as one rad of gamma radiation from cobalt-60.

Roentgen - The quantity of X- or gamma radiation such that the associated corpuscular emission per 0.001293 gram of air produces, in air, ions carrying one electrostatic unit of charge of either sign. 1 roentgen corresponds to an absorbed dose of from 0.92 to 0.97 rad when delivered to muscular tissue.

Scintillation counter - A counter which detects ionizing radiations by the light emitted when they pass through certain materials.

Stable isotope - A non-radioactive isotope.

Threshold dose - The minimum dose of radiation which produces a stated effect. With greater doses the effect may be more intense; with smaller doses it does not appear at all.

Tracer - A radioactive substance used to indicate the behaviour of the stable form of the same substance. Also used to describe the level of activity used in laboratory experiments of this type.

Unstable isotope - A radioactive isotope.

X-ray - Electromagnetic radiation of short wavelength.

DISCUSSION

In the discussion which followed, the question arose as to what the OWRC was planning to do with respect to sampling of water supplies and the analyses for radioactivity of samples which would be submitted by other people. Dr. Berry replied that the Commission was presently working in conjunction with the Ontario Department of Health on some projects. The Radiation Laboratories of the Department of Health are equipped to do many of the routine analyses. However, the Commission has not entered into any full-scale sampling of municipal water supplies, but it is hoped that this can be done at some time in the future.

Dr. Prevost of the Quebec Water Purification Board asked about the monitoring of radioactivity contained in fish in the Ottawa River and he also asked what permissible concentrations would be allowed in the water. He expressed concern with algae and accumulated radioactivity, and that this algae is then consumed by the fish, which in turn are eaten by humans and thus creating a potential hazard. Dr. Leppard, Physicist, Industrial Hygiene Division of the Ontario Department of Health, replied that the Ottawa River has been monitored by the company itself, The Atomic Energy of Canada Limited. However, the monitoring work outside the boundary fence of the company is now being gradually taken over by the Province and by the Federal Government in a joint effort. While figures as to the radioactivity contained in fish in the Ottawa River were probably available, it was not possible to quote them at this time. Dr. Leppard also stated that the standard practice in the disposal of low-level wastes is to adapt them to drinking water tolerances before they are released to the river and that this practice would be observed in any future discharges.

One of the municipal officials in attendance expressed concern with regard to supplying water for fire protection in the event of a nuclear war, and he also posed the question as to how long it would take for the ground water to become radioactively contaminated. Mr. Shikaze, OWRC, replied that he felt it would take quite some time before the ground water became contaminated and also, some of the soils have ion-exchange properties which help to remove some of the radioactive contamination which is present. In a further reply to the question of ground water contamination, Mr. Watt, OWRC, replied that it would depend to a large extent on the nature of the recharge materials; for example, if we were referring to ground water that was in a limestone terrain with very little overburden, infiltration of the aquifer would occur in a relatively short time period, but if it were in an area with considerable amounts of overburden, that is sand or gravel and so on, it would take considerably longer time. Dr. Berry then made reference to the recharge of wells in the London area, which indicated that it took approximately six months for the surface water to reach the well area. Dr. Leppard stated that there would be a definite period when the ground water would be safe, however, water taken from cisterns and dug wells would not be potable.

Another question concerned the amount of radioactivity which would remain, after fourteen days following a nuclear blast. Dr. Leppard replied that fallout, which is a contaminating material, decays in roughly this fashion; quoting the Emergency Measures Organization, that if we know how much fallout there is after one hour after a blast, then at seven times the one hour, you will have $1/10$ of what you had at one hour, and at seven times the seven hours which is about two days, you will have $1/10$ of what you had at seven hours, so go by a tenth of every increase of seven times the time period measured since the initial hour in between. This is the manner in which the short-lived fission products will die away, but there are some long-lived fission products contained in the radioactive debris which one cannot count upon to act in the same manner. In general, it is a very difficult subject to predict upon in advance.

The Emergency Measures Organization will tell you that if you have a source of water or a body of water that is suspicious of this contamination, then you should have some sort of survey meter that will tell you whether it is sufficiently uncontaminated to drink, however, the test is only good for the first ten days, and this test is to hold the survey meter close to the sample of water, and if a reading of less than 10 milliroentgens per hour is present (approximate), it is probably safe to drink for a short period. This reading would be hair-raising at this time, but one would hope that this sort of war would not last too long, and that some sort of service can be organized.

Professor Andrews, Nuclear Physicist from the University of Toronto, stated that the problems concerning water supplies at the present time were the maintenance of activity levels which were very low and worked out on the basis of exposure over a lifetime. In the event of an atomic war in one's lifetime (and assuming that there were no more than one), the exposure to radiation would be many, many thousands of times the maximum permissible concentrations which have been set up. He said, (quote), "There would be so much ground contamination under such conditions, it would be foolish not to drink water in an effort to survive. In other words, you're straining at a gnat after swallowing a radioactive camel."

THE INDUSTRIAL WASTE SITUATION IN ONTARIO

F. A. Voegel, Director, Division of Laboratories

and

R. H. Millest, Co-supervisor, Industrial Waste Branch

Ontario Water Resources Commission

presented by

Mr. Millest



I am sure that the previous references to the quantities of water used by the industries of Ontario indicate very clearly the importance of the industrial use of water in water quality management. It is to be expected that this demand will continue to grow at an increasing rate as industry continues to develop in size and complexity, as it seems certain to do. Just how great the future demand might be is difficult to determine, but it has recently been suggested that industrial production should expand by as much as four percent per year for the next ten years. If the industrial use of water follows this same rate of expansion (and it might well be much greater) the three billion gallons per day figure which we now estimate, will become about $4\frac{1}{2}$ billion by about 1972.

Not all of the water used by industry enters into processes, of course, since a substantial quantity is required for cooling or boiler-feed, or other purposes in which there is little, if any, contact with process materials, and therefore can be discharged relatively clean. However, many processes involve the use of water as a carrier of process materials, as a medium for chemical reactions, for separating products from unwanted materials, and so forth, and it is these uses of water that are of concern in this discussion. Since practically every type of industry is represented in Ontario, a study of the problem runs the gamut of the whole industrial field. To indicate something of the contribution of a few, it is noted that between 50,000 and 80,000 gallons of water are required in the production of one ton of paper; between 6,000 and 100,000 gallons per ton of rolled steel; 40,000 to 500,000 gallons per 1,000 yards of woollen cloth; 150,000 to 15,000,000 gallons per 1,000 barrels of refined petroleum; and 70,000 gallons per ton of beet sugar. In at least some parts of these processes, waste materials are picked up and discharged with the waste water, with the resulting wastes as varied as the processes themselves. These are only a few of the many industrial uses of water in Ontario and are not given to suggest that they are the most important sources of water pollution, but rather as illustrations of the quantities of wastes to be considered.

Of more significance in assessing the importance of industrial wastes are the characteristics of the wastes and their effects on the waters that receive them. Just as industrial processes and products vary from one industry to another, so does the type and strength of waste vary.

In general, industrial wastes may be classified in six main categories:

1. Oxygen consuming wastes, high in suspended or dissolved solids.
2. Toxic or acidic or alkaline wastes.

3. Oily, greasy, and/or coloured wastes.
4. Taste and odour-producing wastes.
5. Wastes containing inert solids.
6. High temperature wastes.

Many of the oxygen-consuming wastes and those containing settleable solids can be handled by conventional treatment plants. For example, wastes from milk processing, packing houses, canneries, and textile processing and dyeing can be treated successfully, and it is primarily a matter of providing the facilities of suitable design for this purpose. Other types of wastes, such as metal-finishing wastes, can be reduced or removed by chemical treatment, although the facilities required are more specific for each situation at hand, and close supervision and control is required if the treatment works are to produce a continuously satisfactory effluent. Solid wastes, including mine tailings, gravel washings, and steel mill scale, can be settled and impounded by conventional means. Oily wastes similarly can be treated in well-established processes, although it may often be necessary to use chemical or biological treatment in conjunction with the standard physical separation that can be made.

Some wastes, however, are not amenable to conventional treatment in the practical sense, and it becomes necessary to look beyond the high-grade treatment that applies to some of the foregoing. Where such treatment can be achieved only at a prohibitive cost, it is obvious that new methods of waste control or treatment must be found. An example of this latter group would appear to be the pulp and paper industry. In spite of the concentrated effort in research and the pilot scale testing of new pulping and waste treatment methods, some of the waste disposal problems, (notably the disposal of spent sulphite liquor) defy practical solution.

Prior to the formation of the Ontario Water Resources Commission, much of the early effort in industrial waste pollution control in Ontario was devoted largely to the study of specific waste discharges which had been long standing sources of trouble. This approach is still necessary and forms an important part of the Commission's field approach to the problem, but more emphasis has been placed in the past few years on the collection of information which will evaluate total industrial waste loading in geographical areas (counties, municipalities, etc.) and to the examination of industries with similar processes to permit a uniform approach wherever possible to the disposal of wastes from a particular type of industry throughout the province, (pulp and paper, plating, etc.). By closely examining all industrial waste disposal in a single municipality, for instance, the Commission

is not only able to determine the capacity required for handling industrial wastes in a municipal sewage treatment plant, but can also predict any adverse effects which certain wastes may have on the treatment facilities or process, and set out requirements for remedial pretreatment. The approach on an industry-type basis allows an over-all appraisal of the problems relating to industries in similar groups, and promotes a group or co-operative attack on the problem by industrial associations or groups. This latter approach further permits the Commission to deal with all industries operating under similar circumstances, and is often of great value to the Commission in ensuring that its approach to a particular type of problem is realistic and feasible. (e.g. Pulp and paper area Committees.)

Turning for a moment to the actual collection of data through industrial waste surveys, the appraisal of any particular problem is made using information concerning the type and quantity of raw materials used, the processes involved in their manufacture into finished products, the quantity of water used, the scheduling of work, the collection and analyses of samples of the wastes, and the interpretation of the analytical results. With a complete list of raw materials and descriptions of the processes involved, it is possible to evaluate losses beforehand, since the materials which do not appear in the final product, or which are not recycled in the process, will usually appear in the waste streams in one form or another. In addition to knowing the quantity and types of materials and processes involved, the duration or frequency of application of the various steps in the processes is necessary in establishing a sampling programme that will yield reliable information without which a reliable interpretation of the analytical results can be made. For example, batch processes, with a resultant intermittent, or highly varying discharge of waste, must be sampled much differently than if the process is continuous throughout an operating day. Without having a working knowledge of such variations in processes, an investigator might get a completely misleading picture of the waste disposal situation from a series of grab samples taken at random without any relation to the processes producing the wastes.

In general, industrial waste surveys are planned to permit as extensive sampling as possible throughout a complete cycle of any particular manufacturing process. Where production is fairly continuous on a round-the-clock basis, sample points on the sewers are selected from which a good cross-section of the total wastes and the component waste streams can be obtained by composite sampling. Samples are collected in 8-hour shifts around the clock where automatic samples are available, or by hourly grabs for one or more 8-hour periods where manual sampling must be done. The 8-hour composites are then considered to be

representative of the wastes for the operating period in question, and are usually supplemented by grab samples of peak loadings that are encountered during the sampling period. Waste flows are either measured or estimated for the sampling periods so that the total waste loading can be calculated. Where discharges are strictly of a batch nature, grab samples of the batch discharges, with information regarding the volume of each batch and the frequency of discharge, are collected.

After the samples have been collected, they are delivered to the laboratory in Toronto as quickly as possible for analysis. Analyses include measurement of the BOD or biochemical oxygen demand, Chemical Oxygen Demand, total, suspended and dissolved solids, volatile suspended solids, pH, alkalinity and acidity, cyanide, chromium, copper, zinc, and other metal ions that may be known or suspected to be present, phenols, oils and greases, or, in general, determinations of any components that are considered to be important in any particular industrial process. It is here that a working knowledge of every process that is encountered is necessary to ensure that the analyses which are done are going to be significant and useful in determining the waste loading and recommending waste treatment or other remedial measures.

Although the Commission does not provide detailed consulting services to the industries with which it deals, a report of each investigation is prepared and made available to the industry in question, pointing out the level of waste discharge that has been found, and indicating the need for control of certain components of the waste in keeping with the Objectives of the Commission. The choice of the method of controlling a waste and the specific design of equipment or facilities to be used is left to the discretion of the industry, although assistance of the Commission staff is made available if requested. Repeated consultations are had in any event, so that the Commission can follow the development of the waste control programme whether the Commission is directly involved in the mechanics of the situation or not.

Although the Commission has been operating only a few years, industrial waste data have been collected for most of the major industries in the Province. Detailed surveys of the total industrial waste discharges to the municipal sewers in some twenty-five to thirty municipalities have been made, including Windsor, Sarnia, Welland, Niagara Falls, Brantford, Kitchener-Waterloo, Paris, Peterborough, Belleville, Trenton, Cobourg, Lindsay, only to mention a few. These surveys have found valuable application in determining the needs for treatment in the municipal treatment plants, and in determining the sources of wastes which interfere with the operation of existing plants.

Although industrial wastes have very often been the bane of sewage plant operators in the past, and in some cases still are, treatment of many wastes in municipal plants is very often the only practicable solution, and as long as pretreatment is provided at the industry so that the waste loading is in keeping with the ability of the municipal plant to handle them, it is reasonable that these wastes should be so-treated.

As area surveys, on a municipal or county basis, were extended, it became possible, as I indicated earlier, to extract waste disposal information according to industry types, and this is now being done with respect to several industries which are located throughout the Province. The pulp and paper industry, plating and metal working, tanning, brewing and distilling, oil refining, mining, canning, milk processing and cheese manufacture, and others with processes which give rise to wastes that are similar throughout a group, lend themselves to a fairly common approach. An overall appraisal of the problems confronting industries in such similar groups permits the application of certain basic waste treatment information to all similar problems, and also makes possible a reasonably uniform approach to all industries within certain competitive fields. This latter is considered important from the industry's point of view, since anything that reflects on the competitive position of one company or plant in relation to its competitors, is viewed with concern by industry, and it is logical that industry should ask that the requirements for pollution control be realistic and feasible for this reason alone. Where new industries are to be located, a knowledge of the waste control and treatment capabilities of the particular type of industry permits the establishment of initial control which can usually be provided for in new plant design or location, but which is not always possible in older existing plants.

Looking at the progress which is being made in industrial waste control, a great deal has been done by the petroleum industry, canning, dairy, and other food handling industries, plating and metal working industry, the mining industry, the steel industry, the pulp and paper industry, although, as I indicated at the beginning, it is recognized that many of the problems still remaining in this latter still remain because of the inherent difficulties encountered in the processes themselves and the prohibitive cost of applying some of the conventional treatment methods. With the exception of industrial accidents, which usually defy predicting, pollution control from the oil industry can now be made completely effective. The success of control programmes at Sarnia and elsewhere can be cited. Other industries can boast equally effective control and it is usually only where difficulties are encountered in the physical set-up of the plants themselves that waste control has not been completely satisfactory. Some of the difficulties

seem superficial at first glance, but it has been our experience that the inability to adapt known treatment or control methods to existing plants still remains one of the most difficult problems.

Although we may not always agree with industry on how quickly they should move forward in providing waste treatment, or on the degree of treatment that may be required, industry is unanimous in accepting the principal that treatment and control must be ultimately provided. It does not seem likely that the complete solution to the industrial waste problem will come quickly. However, as the present processes and facilities are overhauled and reviewed, suitable waste handling is being incorporated as an integral part of the industrial undertaking. In the meantime wherever it is practical to do so, the application of known treatment methods is being required to eliminate those conditions which have been a source of concern to all.

DISCUSSION

Following the presentation of Mr. Millest's paper, Mr. Snider commented on the excellent co-operation which has been obtained from industries in attacking the problem of waste disposal. For many industries solution to the problem would involve considerable expense and it is necessary, in many cases, to stage the work in phases over a stated period of time.

Dr. Berry commented on the question of the desirability of issuing permits for the discharge of industrial wastes. The Commission has not yet found this practical, at least as far as existing industries are concerned, because of the difficulty in keeping up with the continuing change in processes and methods. The Commission has taken a very broad approach to the inspection and control of industrial wastes, but has not yet felt that a rigidly controlled permit system can be applied successfully.

Mr. Snider commented further, indicating that the present OWRC ACT was being revised from year to year, and that it now provided for control of all waste discharges, and would be further amended as found necessary or desirable.

CONFERENCE BANQUET ADDRESS

Honorable F. M. Cass, Q.C.
Minister of Municipal Affairs



King Edward Sheraton Hotel
Toronto



Tuesday evening,
November 21, 1961

This Conference on Water Quality Management impresses me a great deal. It recognizes the necessity for protecting the water resources of this province against pollution. It reveals a successful effort at a cooperative approach to this problem and it indicates clearly the desire of the Commission to assist others and to lead in this essential work of developing and managing our water resources for the benefit of all. I can think of no better way in which a great national problem can be solved than through conferences of so many groups as is being done here. I understand that the first of these conferences last year approved by the Commission was successful in the information exchanged and in the conclusions reached. I have no doubt but that at the conclusion of this gathering a further step will have been taken along the road to success.

The water resources of Ontario are among our greatest assets. We have an adequate rainfall, we have lakes and basins for storing this rainfall, and we are able to utilize the underground for a great reservoir of water to be withdrawn as we need it. But who can expect any valuable asset or possession to retain its value and serve our everyday wants if we abuse it or fail to apply intelligent management procedures? It will be apparent to all that this management must include many features, and that quality control is one of the greatest of these. A product devoid of quality may be of little value, and when water is degraded by pollution it is almost as useless as no water at all. You are here to examine management programs which will ensure satisfactory water for our many needs.

Ontario is experiencing a tremendous growth, both in population and industrially. The fact that so much of this expansion is taking place in urban centres brings many problems in the supply of water and its protection against pollutants. I understand that some of these industries need vast quantities of water, and that many of the commercial products we have come to consider as necessary to our convenience and welfare may have objectionable effects if they reach these streams. Their manufacture can leave waste products which even in minute quantities can be felt in our rivers and lakes. There can be no doubt that we must protect these water resources so that they will be safe for domestic consumption, and that they will not jeopardize fish and aquatic growths, or interfere with recreation, agriculture, or the many uses we expect of waters. This necessity is growing daily as our greater population and concentration in urban centres means that we must use water many times before it escapes to the sea. There is need for research and aggressive management to enable this multiple use of water to take place successfully. We cannot expect that the wastes of communities and industries can be excluded from watercourses. That is the natural outlet, and in so many instances these effluents must go into waters where intake pipes are no great distances away. Lakefront municipalities are seldom in the position

so desired by Chicago of running their wastes into a drainage canal and diluting these with water diverted from that lake. We must find means of safely using our watercourses to receive adequately treated wastes and not to become impaired for these multiple uses. I am convinced that with joint action using the sciences and skills of many disciplines this goal can be achieved.

It is most gratifying to see at this Conference so many representatives from all over the province and a number of guests from elsewhere. This is clear evidence of your interest in this subject and in your desire to participate in the protection of our water resources. The fact that so many groups as municipal officials, industrialists, conservationists, public health workers, educators, agriculturalists, engineers, scientists, administrators, and so many others are prepared to meet together in a common interest is a great tribute to your foresight, intelligence, and your public concern in the welfare of this province. Under such circumstances you cannot fail.

The Ontario Water Resources Commission has been in operation for only a short time, just since 1956, but it has achieved an enviable record. The Commission are devoted men, dedicated to public service of the highest order. They have assembled a highly capable staff, and the programs undertaken are having a marked effect on the welfare of the province. Their assistance to municipalities in supplying water and sewage utilities means much to these people. I have experienced the benefits of this service to municipalities, and I am looking forward to my closer association with this administration, which form I understand is unique in the world. It is a service organization whose objective, I am sure, is efficiency and economy in public works.

Many people and organizations have contributed much to the progress being made in gaining control of water pollution. To them all we owe much, and I am pleased to note the action taken last year by the Commission in creating a "Distinguished Service Award" to recognize that singular service in the advancement of pollution control. I congratulate the two recipients of this distinction this year in the persons of the Hon. Charles S. MacNaughton and Ross L. Clark. It is also a distinct pleasure to have with us tonight two of last year's awardees in the persons of Frank H. Kortright, President of the Conservation Council of Ontario, and R. J. Hull, President of Cities Service Oil Company. Both have given tremendous leadership and guidance in this work. Their actions will be a great stimulus to others.

I am sure this Conference will achieve marked success. I know it will be our wish in the Commission to maintain a close contact with you at all times and to receive your suggestions and cooperation.

SECOND ANNUAL PRESENTATION
OF THE
ONTARIO WATER RESOURCES COMMISSION'S
DISTINGUISHED SERVICE AWARDS

Conference Banquet -- King Edward Sheraton Hotel, Toronto

Tuesday evening, November 21, 1961.

PRESENTATION OF
DISTINGUISHED SERVICE AWARDS

Below, Dr. James A. Vance of Woodstock, a member of the Ontario Water Resources Commission presents Ross Clark, Commissioner of Works, Metropolitan Toronto, with his award. Top, right, A. M. Snider of Waterloo, Chairman of the OWRC, presents Hon. Charles S. MacNaughton of Exeter, Minister Without Portfolio in the Ontario Government and a former member of the OWRC, with his award. Citations which accompanied both awards are on the following two pages.

In the picture bottom left, from left to right are F. H. Kortright of Toronto, one of the first year award recipients in 1960; Mr. MacNaughton; Mr. Snider; Mr. Clark; and Mr. Robert J. Hull of Toronto, another 1960 recipient.



DISTINGUISHED SERVICE AWARD
ONTARIO WATER RESOURCES COMMISSION

CITATION

ROSS LEOPOLD CLARK

Commissioner of Works, Metropolitan Toronto

The Ontario Water Resources Commission is privileged to recognize your many accomplishments in the control of water pollution.

The Municipality of Metropolitan Toronto, with its great concentration of population and industry, has been called upon to face many problems since it undertook to provide essential services to thirteen municipalities. One of these serious problems was the construction of trunk sewers and pollution control works. No community can hope to protect its people and to ensure a healthy environment without effective sanitary measures. The manner in which this vast program was developed and put into effect for Metropolitan Toronto won acclaim for efficiency and devotion to duty.

Mr. Clark has shown an enviable record of leadership in providing waste treatment facilities and in protecting the waters of the lake against pollution. He has also given of his time and energy to promote the cause of pollution control in serving as President of the Canadian Institute on Pollution Control. He has never failed to give direction to a progressive approach to the abatement of pollution in all its forms.

It is an honour for the Ontario Water Resources Commission to recognize the leadership qualities of Ross Leopold Clark by conferring upon him this Distinguished Service Award in the interests of pollution control.

DISTINGUISHED SERVICE AWARD
ONTARIO WATER RESOURCES COMMISSION
CITATION

CHARLES STEEL MACNAUGHTON

Member for the Provincial Parliament for Huron, and Minister Without Portfolio.

The Ontario Water Resources Commission wishes to recognize the leadership you have given in the advancement of water pollution control in Ontario and in the protection of our water resources.

The water resources of any country must be considered as one of its greatest assets. Conservation measures are of prime importance if these waters are to be made available to all areas to serve human wants, industrial growth, agriculture, recreation, and the many other uses which are expected of water. The rapid growth experienced in this province and the concentration of much of this in urban centres has made the protection of these water resources from the effects of pollution one of our most serious problems. Polluted water is little better than none at all, and much more dangerous. A far-sighted policy of pollution control is imperative if the welfare of the people is to be assured:

Mr. MacNaughton has given marked leadership in this program and unstintingly of his time and energy. As Chairman of the Standing Committee on Conservation of the Legislature in 1959 he gave emphasis to the necessity for effective conservation measures for all our resources. He served for nearly two years as a Member of the Ontario Water Resources Commission before joining the Cabinet. In that position he made a marked contribution to the program for clean streams for Ontario. He stimulated the adoption of waste treatment programs for municipalities and industries, and was instrumental in arousing public support for these many projects.

It is an honour to recognize the work of Mr. MacNaughton and to present him with this Distinguished Service Award in appreciation of his leadership in pollution control.

LEGISLATION AND ITS SIGNIFICANCE

Henry Landis, Solicitor

Ontario Water Resources Commission



Presentation of this paper and the subsequent discussion, scheduled for the Tuesday afternoon session, were carried over to the Wednesday morning session.

Direct control of the quality of water for public purposes--that is, generally speaking, water supplied by a company public utility, a public utilities commission or by a municipality--is given to the Ontario Water Resources Commission under a section of the Ontario Water Resources Commission Act that empowers the Commission to make orders with respect to the treatment of such water. Contravention of any such orders is made a summary conviction offence.

Acting under this power the O.W.R.C. tests and assesses the quality of water produced by waterworks throughout Ontario for public use, and gives specific directions respecting all phases of the filtration and chemical treatment of such water. The Commission's standards for this treatment are intended to produce a quality of water for public consumption at least as high as that set out in the generally acceptable "Drinking Water Standards" of the United States Public Health Service, and in accordance with the Commission's suggested "Drinking Water Standards."

In addition to dealing with the treatment of water, the Commission is empowered to make orders with respect to the collection, production, storage, transmission, distribution and use of water for public purposes. Orders dealing with such matters may, in some instances, improve the quality of water. Examples include: an order requiring the collection of water at a certain location may improve its quality; an order relating to the production of water (i.e. requiring a decrease in the rate of well pumping) may improve quality by allowing water to be abstracted from a smaller than usual area; an order specifying a method of storage, such as requiring a cover on an open reservoir, may protect treated water from deterioration; an order for artificial storage at the source of supply, such as requiring a dam to be built in a river, may result in reduced turbidity by natural sedimentation and thereby result in better quality; an order prohibiting the use of cast iron mains in certain distribution systems may prevent water quality problems that might otherwise arise from the reaction between aggressive water and the cast iron mains; an order limiting the use of water in a municipality, in order to relate the demand for treated water to the treatment capacity of a waterworks, may prevent deterioration that would result from operation of the plant beyond its capacity.

The Commission is also empowered to make regulations prescribing standards of quality for potable and other water supplies, sewage and industrial waste effluents and receiving streams and watercourses. Although these powers have not yet been exercised, the Commission is achieving its objectives in these matters by other controls under the Act.

In parts of the United States different grades of water quality exist for different watercourses. Such grading makes it possible for some watercourses to be maintained at a level that can be made, with normal treatment, suitable for human consumption, and other watercourses to be maintained at a level suitable for industrial use but not for human consumption even with such treatment.

The difficulty with such gradation is that it tends to fix the quality in certain watercourses without regard to possible changes in the economic character of the surrounding area and to make it very difficult to obtain a better quality of water if necessary. In Ontario no such formal gradation exists and the OWRC attempts to maintain the quality of water in all watercourses, including those that receive sewage and industrial waste effluents, at least in accordance with its "Water Quality Objectives" or, in accordance with such higher standard of quality as is possible under the circumstances. Water that meets the "Objectives" can, with normal treatment, be made suitable for human consumption and ordinary domestic use. If the Commission's suggested standards of quality for sewage and industrial waste effluents are complied with, the water in most watercourses that receive sewage and industrial waste effluents will meet the "Water Quality Objectives". While these "Objectives" do not have the force of law, there are various inducements to municipalities and industries to comply with them.

INDUCEMENT TO COMPLY

One inducement is to avoid prosecution under a section that provides that every municipality or person that discharges or deposits any material of any kind into any well, lake, river, pond, spring, stream, reservoir or other water or watercourse or into or in any place that may impair the quality of any such water, is guilty of an offence. It should be noted that it need not be proved that the material will impair the quality of the water--it is sufficient to show only that the material may impair the quality.

It is necessary to relate the quality of water to the purpose(s) for which it will be used; quality for human consumption necessarily differs from that for industrial or recreational use, or for conservation of aquatic life. Since the section does not define the quality of water that might be impaired in order for an

offence to take place, and is not limited to the quality of water for any particular purpose, the deposit or discharge of material that may cause the quality of the water to fall below that required for any of the purposes for which the water is suitable, is likely an offence. For instance, where water is suitable for human consumption without any treatment, the discharge of material that might make it unsuitable without normal treatment, is likely an offence; the discharge of the same material into water that is already unsuitable for human consumption without normal treatment is likely not an offence.

It should also be noted that there need not be a possibility of impairment of the water in the entire watercourse or receiving stream but merely the possibility of impairment at the place where the material comes into contact with the water, because impairment of any part of the water might impair the quality of the whole. Any other interpretation would mean that the section would not apply if the contaminating material were discharged into a large body of water such as one of the Great Lakes.

In addition the Commission is empowered to define an area surrounding any source of public water supply wherein no material of any kind that may impair the quality of the water in such source may be placed, deposited or allowed to remain. Once defined, the owner must give notice of the area by such means as the Commission deems necessary. An offence is committed if the material may impair the quality, or if there is bathing or swimming in the area. Generally, this section would be most effective where a well or spring is the source of public water supply since such a source is not as likely to receive contaminating material from outside the defined area as is a lake or river, and thus defining the area would give reasonable protection.

The Commission is aided in proving an offence by a section providing that in any prosecution a report of the Commission's analyst of the analysis or quality of any water or material is prima facie evidence of the facts stated in the report.

Still another inducement to comply with the "Water Quality Objectives" is a section under which the Commission, with the approval of the Minister of Municipal Affairs, may require any industrial or commercial enterprise to install, construct or arrange such sewage treatment facilities as the Commission deems necessary, and to keep in repair and operate such facilities as the Commission may direct--if the enterprise makes arrangements for sewage disposal unsatisfactory to the Commission, or makes no arrangements at all. This section has particular application to industrial wastes.

INVESTIGATING POWERS

Broad investigating powers in order to exercise effectively control of water quality and to produce evidence upon which a court can act to remedy an impairment of quality are given to the Commission. These include the supervision of all surface and ground waters in Ontario used as a source of supply and the right to examine such waters from time to time to determine what, if any, pollution exists and the causes. More generally, the Commission and its employees or agents may at any time, without consent and without compensation, enter the lands (including lands over which there is water) or buildings of the Province or of any municipality or of any person and make such surveys, examinations, investigations, inspections or other arrangements as are deemed necessary.

The Commission may inquire into, hear and determine complaints by any person entitled to the use of water that any material of any kind that may pollute the water and so impair its quality or render it unfit for its normal use is being placed in or near the water. While the Commission may report on measures to remedy such a situation, the report has no legal effect. However either the Commission or any interested person may apply to the court for an order to implement the report. While the court need not accept the report, it may do so or require further evidence and it may make such order as it deems proper.

So far only direct controls have been dealt with but there are also less direct controls in the Act. For instance, the Commission is given control over the establishment of, or the extension of or any change in existing, water or sewage works subject to the requirement of approval in the Act. Where any of such events is planned, the Commission must be provided with plans and specifications, an engineer's report of the water supply and of the work to be undertaken, the location of the discharge of the effluent and such other information as it may require. Until the Commission's approval is given to the proposed works and in the case of waterworks, to the source of supply, the works cannot be proceeded with nor can a by-law be passed for financing. Approval of the Commission can be refused or can be granted on such terms and conditions as it deems necessary. If prior approval is not obtained as required, the Commission may carry out investigations, and, in accordance with other legal requirements, direct changes in the works, the source of supply and in the location of the discharge of the effluent. Where a waterworks is involved these powers

permit control of the nature and extent of chemical or other treatment and thus of water quality. Where a sewage works is involved, these powers permit control of the nature and extent of sewage treatment and thus of the quality of the effluent discharged into a watercourse. This has a material effect on the quality of water in such watercourse.

When it is considered in the public interest to do so, the Commission may require a municipality to establish, maintain, operate, improve, extend, enlarge, alter, repair or replace any water or sewage works subject to the Act by a report in writing to the clerk of the municipality. It is an offence for a municipality to fail to do everything in its power to implement such a report. Since "sewage" is defined in the Act to include drainage, storm water and commercial and industrial waste, "sewage works" include storm sewers and other surface water drainage works.

The Commission is also given power to construct, acquire, provide, operate and maintain sewage and water works, to make available supplies of water to, and to treat and dispose of sewage delivered by, municipalities and persons, and to make agreements with respect thereto. As an aid the Commission may exercise any or all of the power conferred by any general Act upon a municipality respecting the establishment, construction or operation of sewage and water works. These include powers of the municipality under The Public Utilities Act, The Municipal Act, or The Local Improvement Act. In addition the Commission may conduct research programs and prepare statistics. Acting under these powers the Commission has conducted research into chemicals to control algae in watercourses, has made agreements for test drilling to ascertain if sufficient water supplies are available for well development, has purchased existing water and sewage works, and has improved extended and operated them for municipalities.

Acting under its power to provide and operate water and sewage works for one or more municipalities on financial and other terms more favorable to the municipalities than if they were to do so independently, the Commission has in operation, in the process of construction or about to be constructed at this time 192 projects involving 146 municipalities. These projects have had a marked effect in improving the quality of water produced for public consumption or present in watercourses into which sewage effluent is discharged.

Other powers of the Commission permitting control of water quality to varying degrees, include the power (a) to licence the business of boring or drilling wells for water, (b) to make regulations controlling water well

construction and their repair and alteration, (c) to make regulations controlling construction, repair or alteration of plumbing, (d) to make regulations controlling the content of sewage entering sewage works, (e) to make regulations prescribing operating standards for water or sewage works, and (f) to make regulations controlling the use of water from any source of supply.

The Commission has power to require the reporting of information concerning sewage and water works. For instance, the holder of a licence to bore or drill water wells must report prescribed information to the Commission within one month of completion of the work, and the owner of a water or sewage works must report to the Commission such information as it requires. Failure to do so is an offence. Other sections require water and sewage works to be maintained, kept in repair and operated in such a manner and with such facilities as the Commission may direct. These powers enable the Commission to assess the quality of water produced by waterworks and the quality of effluent discharged by sewage works, and thus to give specific directions for the maintenance of proper operating standards and for the improvement of facilities and equipment.

CONTROL UNDER THE PUBLIC UTILITIES ACT

In order "to secure to the inhabitants of a municipality a continued and abundant supply of pure and wholesome water", a section of The Public Utilities Act confers power upon a municipality to pass by-laws for regulating the time, manner, extent and nature of the water supply by the municipal waterworks, the buildings or persons to which and to whom the water shall be furnished, the price to be paid, and other relevant matters. The words "pure and wholesome" specify a standard of quality for the water produced by the waterworks that every by-law passed under the section must be intended to achieve in order to be valid. The case of Metropolitan Toronto v. Forest Hill (1957) S.C.R. 569 decided that if the purpose of such a by-law is to carry out preventive or other medication (i.e. the addition of fluoride to render teeth less susceptible to decay or the addition of water soluble vitamins or minerals to promote health) the by-law is not intended to secure a supply of "pure and wholesome water" and is invalid.

Sections 9 and 55 of the Act impose statutory duties on municipalities that have a waterworks to supply water, in accordance with their terms, to all public

institutions situated in or within three miles of the municipality and belonging to or maintained by the Province and, where there is a sufficient supply, to all buildings within the municipality situate upon land lying along the line of any supply pipe upon the request in writing of the owner, occupant or other person in charge of any such building.

Since the sections do not specify expressly the quality of water that must be supplied, it is necessary to determine whether they require the supply of water of a particular quality. The following court decisions should be considered.

St. Lawrence Rendering Co. Ltd. v. The City of Cornwall (1951) O.R. 669. The court held that where water is supplied pursuant to a duty imposed by statute, it is not and cannot be supplied pursuant to a contract. It follows that there can be no standard of quality established by contract for water supplied pursuant to the sections mentioned above. It is suggested that the quality of such water must be the same as the quality that is required at common law of a supplier of water as set out in the case of Munshaw Colour Service Ltd. v. Vancouver (1960) 22 D.L.R. (2d) 197, reversed (1961) 29 D.L.R. (2d) 240. Here the trial court held that the quality required of a supplier at common law is that the water must be wholesome and ordinarily pure; i.e., it must be fit for ordinary human consumption and domestic use. The quality of the water need not be suitable for the particular purposes of any consumer who requires a quality better than "wholesome and ordinarily pure", and the U.S. Public Health Service "Drinking Water Standards 1946" furnish a reasonable and acceptable definition of this quality. The reversal of this decision by the Court of Appeal does not affect the decision of the trial Judge relating to the quality of water required at common law.

A contrary view is implied in the Scottish Ontario Manitoba Land Co. v. The City of Toronto (1899) 26 O.A.R. 345. Here the statutes, pursuant to which the water was supplied, did not specify expressly a standard of quality. The water that was supplied contained sand that damaged the plaintiff's hydraulic elevators. One member of the court held that a duty was imposed by the statutes to supply water, and went on to state "it is unnecessary to express any opinion as to the rights of the parties aggrieved or fancying themselves aggrieved by any breach of the statutory duty created under these Acts, as no such breach was proved by refusing to furnish water as required whatever may have been the quality of water supplied."

This view appears to mean that so long as water is furnished as required, there is compliance with the duty to supply water under the statutes even though the water may be of a quality unsuitable for ordinary human consumption and domestic use. It would follow that the institutions and owners of buildings supplied with water under the sections above mentioned would have to furnish their own chemical and filtration treatment if this were required to make the water "wholesome and ordinarily pure" as required at common law. It is suggested that such an interpretation of the term "water" in these sections would be contrary to the intent of the legislature, to the expectation of the public and to the general practice in the operation of municipal waterworks.

Where water is supplied pursuant to a statutory power, and not a statutory duty, such as the power under the Act to establish and operate a municipal waterworks, the quality must be, in the absence of a standard of quality prescribed by statute or a regulation or order thereunder or required by a contract, the quality required at common law, namely, "wholesome and ordinarily pure".

CONTROL UNDER THE PUBLIC HEALTH ACT

Any condition existing in a locality that is or may become injurious or dangerous to health or that prevents or hinders or may prevent or hinder the suppression of disease is deemed a nuisance under this Act and is subject to abatement by the local health authorities. For greater particularity, any watercourse or water so foul or in such a state or so situated as to be injurious or dangerous to health, and any well, spring or other water supply in such condition, is deemed a nuisance. Therefore one control under the Act is that the quality of water must not be such that the water is a nuisance, and subject to abatement.

Water quality may be in accordance with these standards and not be a nuisance but still not be in accordance with the U.S. Public Health Service "Drinking Water Standards" or the Commission's suggested "Drinking Water Standards." For instance, water containing either a high concentration of chloride that produces an offensive taste, a high content of iron that may stain laundry or a high concentration of fluoride that may stain teeth, or with a high pH that over a long period of time may adversely affect some types of plumbing or watermains, would not necessarily be a nuisance under the Act, but might constitute a contravention of the duties imposed under The Public Utilities Act or The Ontario Water Resources Commission

Act, or a regulation or order thereunder, or might result in liability for damages at common law if damage is caused by the use of such water.

A section empowers the Department of Health, by a written report to the clerk of a municipality, to require the establishment, operation, extension or alteration of any water or sewage works. However if the works required by the Department are subject to The Ontario Water Resources Commission Act, it appears that the Commission's approval must be obtained before the works can be proceeded with. This section permits control of the quality of water produced by a municipal waterworks and of the quality of effluent discharged by a municipal sewage works into a watercourse.

CONTROL AT COMMON LAW (a) CONTRACT

A contract for the sale of water may require expressly that water of a specified quality be supplied, and in such event failure to do so is a breach of contract and may result in liability for damages. Even if such a contract does not expressly require a specified quality there may still be liability for supply of an unsuitable quality of water based on breach of a warranty of fitness that a court may imply in the contract. In Read v. Croydon Corp. (1938) 4 A.E.R. 631, there is a suggestion by the court that a contract for the sale of water could be regarded as one for the sale of goods and/or the sale of services, and that in the circumstances of the case, a court will imply, in either contract, a warranty that the water supplied will be reasonably fit for the purpose for which it is required. It is likely that where water is supplied pursuant to a contract of sale, the implied warranty in either contract will be implied under the same circumstances and therefore only the warranty under The Sale of Goods Act will be considered here. Assuming water is a "chattel personal" and therefore within the definition of "goods" under the Act and a contract for its sale is subject to the Act, where water is supplied pursuant to a contract and the buyer expressly or by implication makes known to the supplier, whose business it is to supply water, the particular purpose for which the water is required--so as to show that he relies for the quality on the supplier's skill or judgment--there is a warranty implied that the water is reasonably fit for the purpose for which it is required. If it is not reasonably fit, there is a breach of the implied warranty and the supplier may be liable for damages. Such liability is not dependant upon proof of negligence.

Where water is supplied pursuant to a duty imposed by statute, e.g., under sections 9 and 55 of The Public Utilities Act, it is not and cannot be supplied pursuant to a contract of sale (St. Lawrence Rendering Co. v. Cornwall) and in such case there can be no liability based on breach of an implied warranty of fitness. Where water is supplied pursuant to a statutory power there may or may not be in a particular case a contract for the sale of water. Section 11 of The Public Utilities Act permits such a contract between a municipality or a public utilities commission and another person, municipality or commission. Under such a contract water is not supplied pursuant to a statutory duty and liability for the supply of water of unsuitable quality may be based on breach of the implied warranty of fitness.

WARRANTY NOT IMPLIED

Even under a contract of sale a warranty of fitness will not be implied unless the buyer expressly or by implication makes known the purpose for which he requires water so as to show that he relies on the supplier's skill and judgment for its quality. For example, the New York Court of Appeals in a 1920 case, Canavan v. City of Mechanicville, refused to imply the warranty because it reasoned that even though water was being supplied by a municipality under a contract of sale, the municipality could not, with certainty, furnish and know that it was furnishing water that was fit for all purposes in view of the absence of actual control of its water supply, the then-existing techniques for inspection, testing and treatment of water and its lack of knowledge of any particular use to be made of the water. Moreover, the court held that a consumer does not, by merely using water supplied by a municipality, make known the purpose for which he requires it so as to show that he relies on the skill and judgment of the municipality for the fitness of the water for his purpose.

It is suggested that in view of modern techniques and their widespread use in the inspection, analysis, treatment and storage of water supplied for human consumption and domestic use and the public expectation that such water will be wholesome, the Canavan case should not be followed now and that where water is supplied for human consumption and domestic use pursuant to a contract of sale, a warranty of fitness for such consumption and use should be implied.

Support for implying such a warranty was expressed by an English court in Read v. Croydon Corp., in which an action was brought for damages for contracting typhoid fever from drinking water supplied for public use pursuant to a statutory duty. The court stated that if the water had been supplied under a contract of sale, a warranty of fitness would have been implied in the circumstances of the case. These circumstances appear to be that where water is supplied for human consumption and ordinary domestic use, the supplier knows and intends that the public (by its use of the water without a reasonable opportunity of testing its safety) relies on his skill and judgment for its fitness.

Where water is supplied pursuant to a contract of sale for human consumption and ordinary domestic use, but the water is used for a different purpose that requires a better quality of water, a warranty of fitness for the different purpose will not be implied under The Sale of Goods Act--unless there are circumstances showing that the consumer made known, expressly or by implication, the different purpose for which the water was required so as to show that he relied on the supplier's skill and judgment for the fitness of the water for such purpose.

It appears to have been suggested that where water is supplied pursuant to a contract of sale and the consumer has a reasonable opportunity to examine the water before use and to discover that the quality is unsuitable for his particular purpose, there is no reliance by the consumer on the supplier's skill and judgment for the fitness of the water for the purpose and therefore no warranty of fitness would be implied (Scottish Ontario Manitoba Land Co. v. City of Toronto).

Even if the warranty of fitness is implied, damages can only be recovered for breach of the warranty if damage is caused by the water not being reasonably fit for the purpose for which it is required, and with respect to which the warranty is implied. Damages cannot be recovered if damage is caused by the consumer's own carelessness in continuing to use water that is not reasonably fit for his purpose after he could reasonably have discovered that the water was unfit, have ceased to use it and thus prevented the damage. Examples are the continued use of water discoloured by iron for laundry purposes or the consumption of water with an offensive taste after the consumer could have reasonably discovered this, ceased to use the water and prevented the damage.

If water supplied pursuant to a contract of sale meets the 1946 U.S. "Drinking Water Standards" it will be "wholesome and ordinarily pure" (Munshaw Colour Service v. Vancouver) and reasonably fit for human consumption and ordinary domestic use. Generally, therefore, there would be no liability based on breach of the implied warranty of fitness if the quality of such water is unfit for the consumer's particular purpose and damage is caused. However, the supply of water that meets these Standards would not be a defence to liability based on breach of contract if a contract term expressly required water of a better quality, or to liability based on breach of an implied warranty of fitness if the consumer made known that water of a better quality was needed for his particular purpose and the circumstances show that when the contract of sale was made, he relied on the supplier's skill and judgment to furnish the better quality water.

In all cases of a contract for the sale of water it is advisable to deal expressly with the quality that must be supplied and to negate expressly an implied warranty of fitness. An express warranty does not negate a warranty of fitness implied under the Act unless it is inconsistent therewith. The quality of water to be supplied under a contract of sale should be determined by the express agreement of the parties and should not be left to be determined by a court that may imply a warranty of fitness.

(b) NEGLIGENCE

As well as the quality of water that may be required by an express term of a contract, or by an implied warranty of fitness under The Sale of Goods Act, there is the quality that must be supplied in order to avoid a possible liability for negligence. This quality is that the water must be "wholesome and ordinarily pure" that is, must be fit for ordinary human consumption and domestic purposes. It need not be chemically pure nor suitable for the particular purpose of any consumer whose operations may require a better quality than that prescribed by the United States Public Health Service "Drinking Water Standards, 1946" which furnish a reasonable and acceptable definition of what is meant by "wholesome and ordinarily pure" water. This statement of the law was laid down by the trial court in Munshaw Colour Service Ltd. v. The City of Vancouver (1960) 22 D.L.R. (2d) 197, reversed (1961) 29 D.L.R. (2d) 240, where the city was held liable for damage to films of the plaintiff film developing company caused by the negligent

supply of water that contained sediment and was not in accordance with the U.S. 1946 Standards. There being no standard of quality prescribed by a statute or by contract between the plaintiff and the city, the trial court held that the duty of a municipality or a public utilities commission supplying water, at common law, is to supply water that is "wholesome and ordinarily pure".

In Seiden v. Passaic Valley Water Commission (1938) 199 A. 420, the court held a company public utility liable for damages based on negligence because the water it supplied contained sediment that damaged a consumer's plumbing. This requirement that the water supplied be harmless to the common and ordinary means of delivery to a consumer is either an example, or is a reasonable extension, of the duty of a supplier of water at common law as defined in the Munshaw case.

If the water supplied is fit for ordinary human consumption and domestic purposes there can be no liability for negligence if it causes damage because its quality is unsuitable for a consumer's particular purpose. However, in such a case there might still be liability based on breach of an express term of a contract or on breach of the implied warranty of fitness under The Sale of Goods Act.

Even if the water is supplied that is not "wholesome and ordinarily pure" as required by the Munshaw case, and damage results from the use of such water, there will not be liability for negligence if the failure to supply such quality is not caused by unreasonable acts or omissions on the part of the supplier, or is caused by an act or event beyond the control of the supplier. In the Munshaw case the court describes this principle:

"It would not be reasonable to suggest that the city has a duty to supply water suitable for the particular purpose of any applicant whose operations require water of a particular standard of purity...but here the city, having undertaken to supply water to the plaintiff, and having for a considerable period of time supplied it to the plaintiff, was in my view under obligation to supply...water which was wholesome and ordinarily pure, and to continue to supply it with such water unless relieved from that obligation for some reason arising from natural causes." The examples given as relieving the city include an unusually high tide, frost of exceptional severity or a situation where the city had no knowledge of and no reason to suspect the possibility of contamination. In addition, the city may be relieved of the obligation where, having

knowledge of an existing or possible danger, it took every reasonable step to warn users that the water was liable to be harmful by reason of contamination.

It should be noted that the Munshaw case applies where water is supplied by a municipality, a public utilities commission or by a company public utility for general public purposes and might not apply where water is supplied for other purposes. If it were supplied for other purposes and depending on the circumstances, it might be reasonable to require a better quality to be supplied than "wholesome and ordinarily pure" and if such better quality were not supplied and damage was caused there might be liability for negligence.

Where a consumer uses water with an offensive taste, a discoloured appearance or any other clearly observable deficiency that may be due to inadequate chemical treatment or filtration, it may be difficult to establish liability or to recover full compensation for liability based on negligence. The reason is that although such water is not "wholesome and ordinarily pure" and therefore does not meet the standard of quality required by the common law, it is possible to argue that any damage was caused, or materially contributed to in law, by the contributory negligence of the consumer and not by the unsuitable quality of the water. Such an argument is possible if the consumer could reasonably have observed the deficiencies and could have stopped the use of the water before any damage was caused. The law of negligence does not compensate for reasonably avoidable damage even though the water supplied does not meet the required standard of quality because of unreasonable acts or omissions in its treatment and supply.

DISCUSSION

Mr. Archie Lyons, W. O. Chisholm & Associates, Consulting Engineers;

"If you were in the business of supplying water, would you tell me that with every sale you made you would be automatically responsible and would guarantee that the water you were supplying would meet the needs of each individual user?"

Mr. Landis replied:

"I would not tell you that. You would have to prove certain conditions. There would have to be a contract for the supply of the water and The Sale of Goods Act would need to apply to the sale of the water. The person who was buying it would have to make known to the seller the purpose for which he was using it. And he would also have to rely on your skill and judgment in supplying this water. Now, if someone came to you and said I need water for this particular purpose and I am relying on you to produce water suitable for that purpose, you would be liable if you did not produce water for him, for that purpose, that is, if the water was not reasonably fit for the purpose. But if no one told you of his purpose, or made known to you the purpose for which they were going to use this water, then they would not be really relying on your skill and judgment for turning out a product that was suitable for their particular need, and there would be no liability.

"There would be no implied warranty under The Sale of Goods Act although there was a contract for the sale of water. An implied warranty only arises when certain conditions exist, and it is something that exists with the sale of any goods under The Sale of Goods Act. Water is goods, just like a car."

Mr. Lyons:

"But within the definition of an acceptable water, and you market the water say, in a municipality, and under ordinary conditions, this would meet all the requirements. There must be an individual contract for anybody using it for a specific purpose, otherwise they would not be responsible."

Mr. Landis:

"That is right. You've got to have individual contracts for water of a quality better than that set out in the drinking water standards if you are to be responsible for the quality of water for a particular purpose other than ordinary domestic use and human consumption."

Mr. T. W. Beak, Consultant Biologist, Kingston;

"I have a double-barrelled question. I want to get the answer to the first before I ask you the second. These water quality objectives--am I right in thinking they have not been made under the Act inasmuch as to say that they are not statutory?"

Mr. Landis:

"That's right, they haven't the sanction of statute of law in Ontario."

Mr. Beak:

"Well, in that case, I understood you to say, but I might be wrong, in a case, I think it was under section 27, these would be used as the standard quality. Now I suggest that if that is the case they would have to be proved in each individual case, they would not stand on their own feet in court."

Mr. Landis:

"Why, of course, we would bring them into court and ask the judge to accept them. It would be up to the judge to decide whether under section 27 these water quality objectives were to be carried out."

Mr. Beak:

"Well, there has never been a case in which these would not be accepted at their face value. I can assure you in the case of phenols. Can I ask you that? There has never been a case where they have been accepted without proof?"

Mr. Landis:

"Well you have me at a disadvantage because I am not a chemist or an engineer. I am a lawyer."

Mr. Beak:

"But can I ask you that? There never has been a case where they have been accepted at face value?"

Mr. Landis:

"There has not been a reported decision that I know of in which the court judgment accepted the standard of quality set out in those objectives."

Mr. D. Miklas, Markham Township;

"Mr. Landis, I may have misunderstood you, but did you not mention at the beginning of your talk that different regulations governed possibly in different municipalities? Were you speaking legally or technically?"

Mr. Landis:

"No. You did misunderstand me. I pointed out that regulations applied throughout the province in every municipality unless specifically limited in accordance with the OWRC Act. There isn't one regulation for one municipality and another regulation for another. But, specific orders of the Commission directed to the various municipalities may differ. The needs of each municipality would be considered in making each order. Generally an order is a more flexible tool to achieve your objective than a regulation of general application in the province which won't be varied until it is amended."

Mr. Miklas:

"Thank you."

Mr. R. G. McQuillan, North York Township;

"In your last example, with the contract between the bait grower and the water supplier, suppose then the supplier says, "well I can't provide you with water containing the oxygen you need." Can that be written into the contract?"

Mr. Landis:

"If it's a matter of a private contract, of course it can. That is the essence of a contract, that within limits, you can choose to agree to anything you like. If you don't want to agree to something you just specifically exclude it in the contract."

Mr. McQuillan:

"Could the water supplier say, 'I don't want to enter into a contract. I won't supply you with water at all?'"

Mr. Landis:

"Certainly, but a public utilities commission or municipal corporation may be under duty under The Public Utilities Act to supply water to this building. Under section 55, every public utilities commission in every municipality is under a statutory duty to supply water if there is a sufficient supply and if the building is along the line of a supply pipe, and if there is a request

in writing from the owner, occupant or other person in charge of the building for the supply. Probably this water need not be reasonably fit for the particular purposes for which the various businesses in the building are carried on. The section doesn't deal with the quality of the water to be supplied, but likely the quality that must be supplied pursuant to this section is that it must be wholesome and ordinarily pure, as set out in the Munshaw colour service case."

Mr. McQuillan:

"This will probably mean that careful attention should be paid to contracts."

Mr. Landis:

"Well this is something separate from contracts. Where you supply water pursuant to a statutory duty no contract is possible. If a man sends you an application for water and you make the service connection, that is not necessarily a contract, even though he pays rates for the water. If you are carrying out your duty under section 55 of The Public Utilities Act, no contract is possible. Your liability then would be whether you have violated section 55 because you have not supplied water of the quality which that section requires, or whether you have been negligent in the supply of the water."

Mr. McQuillan:

"So, the water can be supplied with or without contract."

Mr. Landis:

"Certainly."



Wednesday, November 22, 1961

PART B --

AN ASSESSMENT OF THE NEEDS
IN WATER QUALITY MANAGEMENT

Morning Session

Fountain Court
King Edward Sheraton Hotel

Chairman Snider:

The next item on our program will be the first item that is listed in the program for today....A Guided Discussion on "The Water Resources Needs of Ontario for the Future". Dr. Berry will conduct this guided discussion.

Dr. Berry:

Thank you, Mr. Chairman. Many of you are familiar with the procedure which is followed in guided discussions, but for the benefit of those who are not, I would point out that we have listed a series of questions and I hope each one has a copy of this. This is intended to open the discussion but it doesn't confine it to those questions alone. The general subject is "The Water Resources Needs of Ontario for the Future". You will recall that yesterday a paper was given by Mr. Watt which set out Ontario's available resources, and what the likely needs would be.

In today's discussion we want to find out the views of this group on certain questions relating to that general subject, and this is one means of getting that information. The first question is, "How are the future needs of the municipalities for water supplies likely to change, and where will this

water come from?" We have asked certain persons to lead in the discussion of this. The first one is Mr. Harry Richards, city engineer of Brantford. He is in a location where, sometimes, it is considered that the water supply of the future might be critical, but perhaps he doesn't think so! Mr. Richards!

Mr. Harry Richards:

Mr. Chairman, I found out on Friday you had asked Mr. Norm Grandfield, our P.U.C. manager, to open the discussion on financing of sewage treatment plants and that you had asked me to discuss water supply. We agreed to switch assignments, but now suggest we combine on this one.

Mr. Snider:

You may have a difference of opinion here. I would think so, and I hope you both give your story.

Mr. Grandfield:

I think, as far as Brantford is concerned, we are about the only municipality now which takes its municipal supplies from the river.

Mr. Richards:

I don't think we are worried about volume unless the Steel Company of Canada wants to move from Hamilton to Brantford. In which case, of course, we would be in trouble. But at the moment we are only using about 2% of the water which flows by our doors. And I think if we could persuade the senior governments to finance a couple more storage dams up above, that 2% could be reduced to about 1%. It is true that we are increasing our per capita consumption. As our population increases our volume or demand will increase. I cannot give you any accurate figures, but I would say the increase is probably in the nature of 3% per annum, which, of course, is a substantial increase. However, our problem is more a matter of quality than of volume. And I think I'll let Mr. Grandfield talk about that phase of the problem.

Mr. Snider:

Now, I didn't think Mr. Grandfield had any problems on quality.

Mr. Grandfield:

Mr. Chairman, we do not have any severe problems on quality, although we do have some minor problems. And, I think we are going to have them for a long time in the future. As already pointed out, we are the only municipality using the Grand River water as our water supply and I believe,

for that reason, it will be a long time in the future before we have an alternative water supply, that is, a source of water from one of the Great Lakes. With our consumption of water in the neighbourhood of six or seven million gallons per day, it is very unlikely that we could find a lake pipeline system which would allow us to sell water at a price within the willingness of industries to pay. Industry is one of our biggest users, naturally, and therefore we must bear in mind that there is another thing other than just water quality, and that is water price. This has a great deal of bearing upon the industries that do locate in Brantford, and there are many of them which are heavy water users. Therefore, there are some problems of quality the solving of which they are not willing to pay for. With our water today, I think there are two chief problems. The first one would be algae. We hope, that with increased storage on the Grand River Watershed, which will give us increased dilution and the possibility that there will be some chemical or natural control of unusual algae growth together with improvements in treatment facilities which we are attempting, we will be able to overcome that problem.

Phenols, which have been mentioned before, are being controlled to a greater extent on that watershed by the OWRC, for which Brantford is most thankful. We hope there will be continued improvement as phenol also is one of the serious problems from taste standpoint.

The other one is the water temperature and even though I am in the electrical business, I can't see very much hope for the future. The temperature of the Grand River in Brantford hits 78 degrees in mid-summer, and our water supply temperature at that time is the same 78 degrees. We calculated how many kilowatt hours per day it would take to cool approximately 15 million gallons of water to a temperature which would be suitable and found we couldn't afford it. However, we do believe that with additional storage and other improvements, that this situation will improve also. That is another problem we have for the future. However, we have lots of water and we can hope for continual industrial growth because we are prepared to supply all the water required, and we feel that we can control the quality.

Mr. Snider:

Thank you Mr. Grandfield. Now, Mr. George B. Crawford, of the Toronto consulting firm of Gore and Storrie will discuss the water resources needs of Ontario for the future.

Mr. Crawford:

How are the future needs of municipalities for water supplies likely to change and where will this water come from?

The needs of municipalities for water supplies can each be so complex with respect to the type of industry located therein, the type of recreational facilities, the prevailing climate and other factors, that it is most difficult

to predict water requirements beyond perhaps 20 years in the future. In considering the question of future water uses, what are the possible courses which the householder and industry may take. As we progress, many decisions will be made on a purely economical concept. As we strive to protect our natural resources, and water is the foremost of these, our decisions may be further influenced by legislation.

The first part of this question is "how are the future needs of municipalities for water supplies likely to change".

According to Ontario Municipal Statistics, the average daily production of water per person by municipal supplies in Ontario has not increased since the close of World War II, although total use has increased by some 54 per cent. It is fair to say that the per capita rate of water use has been controlled by leakage reduction and by improved system operation and maintenance. This control has offset, therefore, the modern rates of water use of household appliances such as automatic washers, of air conditioning units in modern offices and industrial buildings and of the many and variable demands of industries. To this should be added lawn watering which in any municipality invariably creates the high consumption day for any year.

How are these uses likely to influence future water demands? In the case of home appliances, undoubtedly new water using household appliances will come into being and become popular with an affluent society. With metering of house services, however, the actual water use per capita in any household, now less than 50 gallons per day, may increase little or at least only very slowly.

With respect to air conditioning and industrial water use, the estimate of future water use will be influenced by two main controls-- legislation and economics. Legislation may be explained herein, in part, as the quality requirements of industrial effluent into municipal sewerage collection system or into receiving streams. If adequate standards are set for the quality of industrial wastes discharging there-to, the onus will be on industry to discharge only treated wastes. If an industry must produce or purchase water for its uses and subsequently provide satisfactory waste treatment processes before dumping to municipal sewers or receiving waters, that industry will look for ways to re-use water after purchase and before discharging. So much as industry develops the concept of water re-use so will the rate of demand on local municipalities for treated water decrease.

Is there any indication, you may ask, that industry is conserving water? A simple unqualified statement appeared in a recent copy of the Journal of the Water Pollution Control Federation over the name of a gentleman, who is in a position of authority. This statement is that industrial-process engineers have reduced water requirements as follows:

The gallons of water needed per ton produced of - Steel - from 55,000 gallons to 3,000 gallons today; Paper pulp - from 45,000 gallons to 9,000 gallons; Newsprint - from 26,000 gallons to 6,000 gallons; Cannery products - from 2,500 gallons to 1,200 gallons. This simple statement is unexplained and I would invite comments from any members of industry who may be present here.

Indications are, therefore, that the consumption of water on a per capita basis could increase slowly for a few years but that in the foreseeable future, economic or legislative controls could stabilize the per capita use. It is worth mentioning that stabilization economically may be achieved only if all water users are equitably charged for water at rates sufficient to maintain an adequate water system. This point is important since there are many instances in Ontario where industry receives favourable water charges at the expense of other members of the municipality. I might add that this is not necessarily always the industry's fault. Sometimes flat rates established years ago are not adjusted as costs rise.

Although the per capita consumption may stabilize, there is little doubt that the population explosion will continue. In recent years, the population of Ontario has increased at the rate of approximately 3-1/3 per cent annually. In many municipalities, the annual growth amounts to 6 or 7 per cent annually. The province's population, now approximately 5,900,000, could approximate 10,000,000 persons by 1980 and 20,000,000 by the year 2000. It should be safe to assume that the majority of this population will live in southern Ontario, with northern Ontario having a few large urban centres.

The second part of the question is "where will this water come from?"

If the water necessary is that for a population of 20,000,000 persons and if an average figure of 150 gallons per capita daily is assumed, having regard for the foregoing arguments, then the province's water demand for 20,000,000 persons in the year 2000 may approximate 3,000 million gallons per day.

What water assets do we have to supply this demand? The most logical sources of water supply must be considered as surface waters in lakes and rivers and underground water.

Referring first to underground water supply, it is considered that, based on a 30-inch annual rainfall, that underground aquifers might yield 200,000 gallons per day per square mile. If such aquifers existed throughout one fifth of the area, the water yield would approximate the requirements of the year 2000 population.

As the best example of surface water quantity, let us consider the Great Lakes system, to which most inland waters in southern Ontario are tributary. By seaway regulation, Lake Ontario is considered to have a minimum outflow of 180,000 cubic feet per second. If we allow equal use of the Great Lakes' waters by the United States, then Ontario, which fronts all the Great Lakes with the exception of Michigan, would have available a minimum of 90,000 cubic feet per second or some 48,400 million gallons per day. This would be some 16 times the daily water requirements for the 20 million population in the year 2000.

It should not be concluded, however, that either the surface waters or the ground waters could adequately supply the province's water demand in the year 2000. It is obvious that the underground aquifer is not uniform across the province and also that abundant surface supplies of good quality water are not available to each and every municipality. There remains, therefore, for each municipality, the question of quantity of supply and as always, in an engineering investigation, the economic considerations.

Using a withdrawal rate of 200,000 gallons per day per square mile from aquifers, it is considered that such supplies are adequate generally, for small communities. Consider a very large municipality at a density of 10 persons per acre, thus a population of 6,400 persons per square mile. This population would require at least 700,000 gallons per day of water per square mile or some 3-1/2 times the probable aquifer yield. As the cities of Ontario grow into the 100,000 person category, we feel that more consideration must be given to the transportation of water from large surface supplies by way of integrated schemes similar to those already initiated in south-western Ontario.

Although we apparently have an abundant source of water for the possible needs of this province 40 years hence, the time for decision and action is at hand. While we may be most thankful that this province has the great lakes at its doorstep and these lakes have an abundant minimum flow, there are already many instances of local pollution such as to be dangerous to local water supplies. If we are to protect our present abundance of usable water, we believe that more and more available water will have to be re-used in order to meet the future demands of all legitimate water users. The situation commands more research on how to cleanse water, more positive action to keep water resources clean and more public awareness to ensure public support of necessary programs.

Mr. Snider then called on Mr. Elmer W. Goebel, general manager of the Mid-Western Ontario Development Association, for his comment.

Mr. Goebel:

Mr. Chairman, Ladies and Gentlemen: I come from the part of the province where pretty well all municipalities draw their supplies of water from ground sources. We heard yesterday what the potential water supply of the province is and the amount of water we can probably depend on for the next number of years. However, there is some concern within the municipalities, and by some persons who are connected with the development of the particular areas, as to how this water is going to be retained for use in the years to come. If we are to believe the statements made by certain persons in the planning of the future, particularly one gentleman at the recent Resources for Tomorrow Conference, who made the statement to the effect that within the next 40 years, the area of Ontario from Oshawa to London, or beyond, would be one vast asphalt pavement. I am wondering what is going to happen to this 30-inch precipitation throughout the province. Possibly this is more of a conservation problem.

However, it is still water, our most valuable resource. Are we going to continue to let this water run to the lakes and then pay the cost of piping it back to the inland cities? Or are we going to do something to hold it for a period of time which will help to maintain the underground water levels and also the surface water levels, thereby making it more available for the use of the cities and the agricultural people in the central part of our province. I think, as far as industry is concerned, possibly some of the municipal people here might not agree with what I am going to say, but I think in this regard we have to take a very close look at the type of industry that is induced to locate on the central part of the province, with regard to the water requirements of that particular industry.

It is foolish, in the opinion of many of us, to try and induce an industry which is a large user of water to locate somewhere in the central part of the province where the water supplies are at a minimum. Referring to my friend, Mr. Grandfield from Brantford, who mentioned that it is the only municipality on the Grand River watershed that takes its water from the river, we certainly hope that the City of Brantford will continue to be able to do so. I feel, following along his suggestion, that possibly more reservoirs in the upper ends of the Grand will also make it possible for some of the other municipalities on that particular watershed to also use this water, rather than to pay large sums of money to drag it back from the Great Lakes where it is now going.

Mr. Snider:

Would someone else like to make a comment on this No. 1 question? These are the men who have been asked to lead in this. The question is now open for discussion. If not, we are going right on to the second question, "What plans will be necessary to supply industry with adequate water in the future and how will it be related to other uses".

Mr. R. W. Andrews, Polymer Corporation, Sarnia;

I wish to answer this question in two parts, that is, the planning by industry, and the planning required by the regulatory body, in our case the OWRC. As far as industries is concerned, they should plan to locate in areas where suitable water resources are available for their particular operation. It would be unwise to locate a synthetic rubber plant which uses 500,000 gallons of water per ton of product, say, in the London area. On the other hand, breweries seem to find the London area water to their liking, although they are not sure they meet the low volume requirement. Secondly, plant designs should be such that the water is reused as much as possible. This not only would have the obvious advantage of minimizing the intake of water, but also reduce the final effluent to a volume level which could be handled more readily. This is the same point a previous speaker made.

I believe that as far as reducing water consumption by industries is concerned most of the water is used for cooling purposes, that is, the large-volume users. The consumption can be brought down considerably by the installation of cooling towers. The cooling tower's power only costs four per cent, so if the industry was using, say 150 million gallons a day of water for cooling it would bring that cost down to about 6 million gallons, simply by installing a cooling tower. This hasn't been the practice in Ontario, as large industry is usually located right on the Great Lakes next to a source where ice cold water hasn't been much incentive to the storage cooling towers. But this can be done in the future if necessary. Thirdly, industries as well as municipalities must do their part to assure that effluents discharged to the natural water course meet or better the objective described by the regulatory body. This, of course, is particularly important where established industries have outgrown their local water resources and they find relocation is not practical. As far as plans for the regulatory are concerned, I originally had several suggestions, but during yesterday's series of excellent papers by OWRC members, I kept stroking off my suggestions until I had none left. However, I would like to recommend that the regulatory body prescribe, where possible, standard sampling techniques and methods of analysis so that the proper interpretation could be given to results obtained, and so that the industries' methods would be the same as the regulatory body. Perhaps these standards could be presented in manual form, if this hasn't been done already. Also, I would like to suggest that some flexibility in the interpretation of results

might be necessary for some time. The reason I say this is that I believe there will be occasions of heavy industrial concentrations where the intake water of some industries will already contain pollution in excess of the objectives. Situations like this of course will take some time to sort out.

Mr. Snider:

Thank you Mr. Andrews--some good suggestions there! Next on the list is Mr. R. E. Mills of Naugatuck Chemicals of Elmira, Ontario. (Mr. Mills was not in attendance but submitted a paper for inclusion in the proceedings' report.)

Mr. Mills:

It is believed that industry should consider a water management program as a means of providing an adequate water supply in the future.

It is certainly evident by what has already been said at this Conference that the industrial and municipal water demands of the Province are increasing at an alarming rate. There is also the realization that the Province's water resources are no longer inexhaustible. Industry and municipality alike, are beginning to understand that the long range availability of water is important. The need for a program to conserve this vital natural resource is apparent.

There are two big incentives to induce industry to consider a program of water management and re-use. They are: (1) Cost reduction of significance can be achieved through a sound program of water management and (2) An important contribution can be made by industry toward conserving an important natural resource as another step toward being a good citizen.

During the war years there was not the regard for conservation that there is today. The chemical industry particularly was involved in the production of essential war materials.

It was during this era that Naugatuck Chemicals Division of the Dominion Rubber Company Limited, began its operations in Elmira as a war industry. As the Company expanded through the years, its demands for water increased. In its early development years an excellent source of relatively cheap water discouraged any serious consideration of an overall water re-use program in the plant. Water re-use was always carried out at specific processes throughout the plant where it was economically possible.

With the recent increase of almost 30% in the water rate in Elmira, additional processes are receiving further study to determine the economics of water re-use.

Water management has always been practised in the plant to prevent waste of a vital raw material and to minimize the ultimate cost of a pollution abatement program that would inevitably prevail.

The Company has encouraged its employees to:

- (1) Minimize contamination in process.
- (2) Contain the contaminants in the smallest volume of water.
- (3) Prevent dilution of the contaminated water before treatment or disposal.

By following these principles the Company has been able to maintain its volume of contaminated waste water to no more than 20% of the total plant water consumption.

The Company has realized that it costs less to treat a small amount of water containing a high concentration of pollution than a large amount containing a low concentration.

Naugatuck Chemicals began treating the phenolic portion of its contaminated waste flow by chlorination as far back as 1950. By 1954 it had embarked on a study of the bio oxidation process as a means of treating its entire waste volume. Since that time the Company has authorized the expenditure of large sums of money for the development of a biological process capable of treating the contaminated waste water volume resulting from its chemical process operations.

The techniques for treating municipal sewage are fully developed and the equipment employing such methods is readily available. The question is frequently asked, therefore, why those techniques cannot be directly adapted to the treatment of industrial wastes.

The answer is two-fold: (1) The composition of practically every type of industrial waste is basically different from domestic sewage. (2) While the basic composition of domestic sewage is generally uniform, regardless of the location, size or character of the community, there is a complete lack of uniformity between one industrial waste and another.

From the data obtained during the years of extensive laboratory, pilot plant and water usage studies, Naugatuck Chemicals is now on the threshold of a completely integrated water management program including a contaminated waste treatment plant and water re-use system. In this way the Company will be assured of an adequate water supply in the future.

If more water is re-used within the plant, the drain on the local supply is lessened and more water is available for potable and other household uses by the people of the community. In a city in which many industries use water for cooling purposes, the savings to the municipality by the reduction of consumption for this purpose could be considerable and could very well eliminate the need for additional sources of supply.

Mr. Snider:

We now will go on to No. 3--"What can be the expected needs of agriculture for water, and how will the present uses likely be altered?" And the man who is to discuss that is Mr. Ian Burton of the University of Toronto.

Mr. Burton:

Mr. Chairman, I think that in the first place, I should perhaps apologize for being on my feet at all. I am from the University of Toronto and occupy a strangely ivory tower position in relation to most of the people who are assembled here this morning. I should perhaps also apologize for the fact that I am new to the Province of Ontario and have had little experience of agricultural water-use problems in this province. I do, however, have some experience in relation to these problems in the United Kingdom and in the United States, and I think that perhaps one or two general comments based on that experience may have some relevance to the situation which we now face in Ontario.

Water is an abundant resource which can be supplied at low cost. Periodic shortages occur, but this is only because the demand for water has been allowed to get too close to developed supply. All that is required therefore to eliminate water shortage is the development of more supply facilities. These usually include equipment for pumping or abstracting water from its source, treatment, transport to the place of demand, and adequate storage.

Under these circumstances water has been used wastefully. Far more has been used for almost every purpose than is physically necessary, and we have also been careless about the quality of water. This kind of resource use is not necessarily uneconomic. Indeed the wisest use of an abundant resource may be extremely wasteful in physical terms.

This situation does not last indefinitely however. Nor is it universally true. No such abundance of water is found in parts of our less humid prairie provinces. In Ontario, although water demand is far from reaching the potential supply, it does press from time to time on the developed supply. As noted above the traditional approach to water supply has called for the provision of extra supply facilities wherever shortages threaten to become chronic.

The provision of such extra supply facilities is not an unvarying expense. The small village can supply its own water from a well at very low unit cost. As the settlement expands local supplies of water become inadequate, and additional sources must be sought further afield. Thus the price of transport is added to the unit cost of water. As large cities develop, with increasing use of water as a means of disposing of effluents, increased costs are incurred for water treatment. In consequence it is possible to state, that generally speaking the more water that is supplied the greater the unit cost of that water. Rarely is it correct to speak of economies of large scale production in the field of water supply.

It is clear therefore, that in a developing economy the marginal cost of supply of water must at some time exceed the cost of other alternatives. The purpose of my remarks is to draw attention in one or two other alternatives and to suggest how they might be compared.

The most obvious direction in which to move is towards greater efficiency in water use. That developed supplies are used wastefully is well-known and will not be disputed by the gathering. I need only refer to the general manner in which suburban lawns are watered, hour after hour, sometimes for a whole day, without any attention to soil moisture capacity. Most of the water applied to lawns in this way, simply runs off or soaks down to the ground water table and is lost. The general belief seems to be that the more water you apply the greener the grass will become. This illustration could be repeated many times for all types of water use.

What means can be taken to reduce the inefficient use of water? A program of education is needed to inform the public that wasteful water use inevitably results in increased taxation. Perhaps also, there is need to examine the structure of water rates. A rating system based on the theory that "the more you use the cheaper it becomes" is not the way to encourage wise use. Advantages are also to be gained by the application of the tremendous fund of technical knowledge which is at our disposal. More careful control of water quality may also be cheaper than developing new supplies.

Many of the foregoing statements are based on the assumption that the marginal costs of water in Ontario already exceeds the cost of other alternatives. Is this in fact the case, and if so how are these alternatives to be compared? I would suggest that there is increasing need to apply the techniques of benefit/cost analysis to our water supply problems. These techniques have now been well tried in other countries for a number of years. Many of the major snags have been removed. Furthermore a handbook on benefit/cost analysis has recently been prepared with Canadian conditions specifically in mind. The analysis now needs further refinement by application to particular problems.

Finally I wish to call for some action now on the following grounds. If we wait until water demands begin to push on potential water supplies (as will soon be the case in some of our small agricultural watersheds, where water is in great demand for irrigation), severe conflicts will arise between different water users. Action now can do much to harmonize these diverse uses, and true multiple-purpose development will be possible. Secondly, acute conflicts may arise in the legal field. As water becomes increasingly scarce and costly, the English Common Law principle of riparian rights is no longer adequate. Nor would it be wise to adopt unthinkingly the doctrine of prior appropriation, widely followed in the western states.

Attention to these problems now will permit choices to be made between a variety of courses of action. Delay can only mean that the choice is progressively restricted, until only one alternative remains. That will be the traditional alternative of developing new water supplies, often by costly engineering works, and always at increased cost to the community.

Mr. Snider:

Thank you. Mr. Hore of the O.A.C. is next speaker.

Mr. F. R. Hore, Associate Professor, Ontario Agricultural College, Guelph;

Mr. Chairman and gentlemen, I would like to start my remarks on behalf of the O.A.C. representation of the agriculture outlook by commenting on Mr. Neil's statement about fertilizer fertility from the land as being probably one of the major important factors. I didn't speak on this point yesterday because I didn't have some required figures. We were unable to attend your banquet last night because we went home to dig out some values. Illinois figures showing run-off in the years 1941 to 1947 (indicate the following values in pounds per acre per year) nitrogen, three pounds--this is probably a fair amount of nitrogen; calcium, we expect quite high, 14 pounds; magnesium, fairly high, 6.45; potassium .3; and phosphorous--the traces were so small that they could not even measure it. I believe Mr. Neil suggested that phosphorous was an element which is probably highly responsible for the production of algae. Phosphorous is one element which we have a difficult job to keep from becoming fixed in the soil. For this reason it is difficult to see how it could get in the drainage water and become plant food for algae growth.

As for the expected needs of agriculture for irrigation purposes, it is estimated that at present approximately 70,000 acres of land in Ontario are being irrigated. These farmers that are irrigating today make use of this practice because it is profitable to their farm enterprise. For example, irrigation of fruits and vegetables in the Kingsville-Leamington area makes it possible for these farmers to intensify their farm operation, maintain a quality product from year to year, and to compete in earliness of production.

As the population increases, it is expected that irrigation will be practiced more extensively to meet the expanding demand for food. The best prediction of irrigation water demands available at the present time is that contained in the O.A.C. submission to the Ontario Water Resources and Supply Committee in 1955. In this brief, the predicted demand in 1975 for irrigation water during the summer peak use period would be 2,351 m.g.d. This demand is expected to exceed the demand for all other uses in the Province at that time. This report also predicts that there will be approximately 508,000 acres of irrigated land in 1975.

I would concur with Mr. Watt's comment yesterday that his estimated present demand of 1,000 m.g.d. for irrigation water is probably too high. Based on the estimate that there are 70,000 acres being irrigated, I would suggest that the demand was closer to 350 m.g.d. Comparing this demand of 350 m.g.d. with the predicted 1975 demand of 2,351 m.g.d., it would appear that the demand will increase about seven times.

Prof. D. F. Witherspoon, Dept. of Engineering Science, Ontario Agricultural College, Guelph;

Mr. Chairman, Mr. D. Cass Beggs in his paper on "Water Is a Basic Resource" to the Resources for Tomorrow Conference in October, predicted that the water needs of agriculture would increase seven times in the next 30 years. He also predicted that industries' needs would also increase seven times. This includes industry in rural areas.

The trend in agriculture is now to larger farm units. These units approach the size of small industries not only in capital invested but also in their water needs. For example, a 1000 head beef cattle farm would require a water supply of 65 gallons per minute and a 1000 head dairy farm would require three times this supply or 195 gallons per minute.

Naturally agricultural development will take place as close as possible to the market. Ontario will be this market. In Ontario we have the soils and the climate for intensification of agriculture. Industry can move to a water supply whereas agriculture must locate where the soils suit the type of agricultural production. As a result a large percentage of the water supply for agriculture will be derived from ground water. Some supplies can come from the re-use of industrial waste water.

Therefore, a program of scientific water management is required which should include not only the needs of industries and municipalities but also of agriculture. This should be management through knowledge; knowledge obtained through basic and applied research in hydrology.

The problem of water management can be solved by approaching it in three ways:

1. More efficient use of existing water supplies.
2. Improved quantitative and qualitative evaluation of water supplies, particularly ground water by applied research.
3. Scientific management of both surface and ground water with respect to quality and quantity by the application of all known hydrologic principles.

Mr. Snider:

Thank you Professor Witherspoon. In order not to upset the schedule I am afraid we have time for only one more comment.

Mr. Charles Hoffman, Ontario Federation of Agriculture;

I come from the southwestern part of the province, and it would appear to me that the needs of agriculture haven't been expounded here as they should at the present time. I think that perhaps many of you are not aware that we are in need of agricultural irrigation water right now. I am sure that the OWRC knows about Harrow. In our area, in particular, I am speaking for the Federation, an ordinary farmer needs from 20 to 50 thousand gallons per hour for irrigation purposes, and I would like to ask Mr. Landis how much water we may take out of these streams, or how much water we may take out of drilled wells and when we may be able to do this? An ordinary farmer will use as much water as a municipality of two or three thousand people while he is irrigating, and I don't think we should look to 1975 because it is here with us at the present time. I will try to get contact later to find out how much water we will be allowed. I think it is a serious question if we want to feed the population properly.

Dr. Berry:

Thank you. It is a good question, and Mr. Landis will spend some time with you after this session is over. Briefly, the legislation requires a permit for taking of water, but each case will have to be dealt with individually. I hope there will be plenty for everybody.

Mr. Snider:

The next paper to be presented has been prepared by one of the winners of the OWRC Distinguished Service Award in relation to pollution control. A very deserved award it was indeed, and I know that we are going to be very much interested in the paper that he now presents to us-- Mr. Ross L. Clark, Commissioner of Works, Metropolitan Toronto. He has done a wonderful job in Metro Toronto and elsewhere, in regard to pollution control. Today he will speak on the "Correlation that exists between air and water pollution."

THE CORRELATION
THAT EXISTS
BETWEEN AIR AND WATER POLLUTION

R. L. Clark, P. Eng.

Commissioner of Works
Municipality of Metropolitan Toronto



The Conference held in November last year provided a welcome forum for the intelligent appraisal of all matters concerning water in the Province of Ontario. Attention was focused on the seriousness of pollution problems, studies were made of the various interests and programmes for effective control and plans were envisaged for greater co-ordination in this vital work.

While detailed analysis was not explored respecting the inter-relationship between air and water pollution, nevertheless, some of the papers made reference to this implication. Professor D. M. Huntley of the Ontario Agricultural College mentioned that, in regard to the movement of agricultural chemicals to our streams, our factual information is meagre, and this subject should receive more attention. He also stated that such studies should embrace a review of the situations brought about by atmospheric pollution. It is, therefore, considered timely to further assess the problem that is coming to the fore.

Air pollution is by no means a new problem--records mention it dating back to the 14th century. But the advent of smog in recent years has focused attention on the fact that pure air is not an unlimited resource and that our supply of tolerable air is diminishing.

Pure air, comprised of 78% nitrogen and 21% oxygen with certain trace elements, is rendered unpure whenever anything different is added to it, as is the case when impurities are added to pure water. Just as water may contain some foreign material and yet be potable, so may air have some additives and yet be tolerable. Our atmosphere becomes intolerable only when sufficient quantities of pollutants are present.

Air pollution is a chapter in the story of the Industrial Revolution. In early times there had not been sufficient smoke emitted to the atmosphere by goldsmiths at their quaint smelters or by early man with his campfires, or even in later years by civilized persons burning wood to warm their houses, to cause distress to any degree. Smoke created by man's activities, of course, is the simplest and most basic form of air pollution and abolition of pollution by dilution was a satisfactory answer for the nonce.

As the Industrial Revolution intensified with its complex and numerous combustion processes, and industrialized society began emitting a preponderance of injurious wastes into the atmosphere. Coal, smoke, soot and fumes from the

melting of iron and lead annoyed the people in London as early as the 14th century. With the establishment of large, crowded, industrial cities the problem commenced to become more severe. Eventually, it appeared in cities which had no heavy industries whatsoever--the source in this case being coal used in heating equipment in homes and for railway locomotives and power plants. Its present-day dimension has been attained by the widespread use of the internal combustion engine.

* * * *

Scientists place all air pollutants in two categories: namely, aerosols and gases. The aerosols embrace smoke, fumes, dust and mists. They are such minute particles of matter, solid or liquid, that they can remain suspended in the atmosphere for prolonged lengths of time. These particles diffuse light and thereby reduce visibility when in sufficient quantity.

The gases are nitrogen oxides, sulphur oxides, carbon monoxide, hydrocarbons, aldehydes and acids. Ozone should be added to this list for it is a poisonous gas formed by nitrogen oxides reacting with hydrocarbons in the presence of sunlight.

AEROSOLS

Smoke contains both solid and liquid particles. It is the unburned product of incomplete combustion, and may be emitted to the air from the burning of rubbish, the industrial burning of coal or petroleum products, or from the exhaust pipes of motor vehicles.

Fumes are solid particles. They are generated by condensation of vapors from solid matter after volatilization from the molten state, or by sublimation, distillation, calcination, or chemical reaction. They are emitted to the air by many manufacturing processes, such as those used in chemical, paint, rubber and metal industries.

Dusts are solid particles of moderate size. They are released from grinding, drying, sawing, or dusting processes, such as utilized in the rock, cement, asphalt, tile, metal, soap, dried foods, lumber, and rubber industries.

Mists are liquid particles and the commonest examples are fog and steam. Industrially, mists are released mainly in spraying, coating, and impregnating operations. An

organic mist from auto exhaust is formed in the atmosphere by the action of sunlight on olefinic hydrocarbons and nitrogen oxides.

GASES

Nitrogen oxides are formed by all combustion and by certain chemical manufacturing operations. Whenever anything is burned, some of the nitrogen (N) in the air combines with some of the oxygen (O) to form nitric oxide (NO). This gas in turn combines with more oxygen and forms still another gas, nitrogen dioxide (NO₂)

Under intense sunlight, nitrogen dioxide reacts with olefinic hydrocarbons to produce eye irritation, vegetation damage, and visibility reduction. This is referred to as a "photochemical" reaction.

Ozone is the one gaseous air pollutant that is not emitted as such into the air, but is formed in the following manner: nitrogen dioxide (NO₂) absorbs energy from the sun and then breaks down into nitric oxide (NO) and oxygen (O). This single atom of oxygen (O), aided by the presence of olefinic hydrocarbons in the atmosphere, combines quickly with an oxygen molecule (O₂) in the air and ozone is formed. No other method for the formation of significant amounts of ozone is known.

Sulfur oxides are formed chiefly by burning coal or fuel oil for industrial and commercial heating, from burning fuel gas containing hydrogen sulfide in refineries, and from smelting processes. This gas is colorless with a suffocating odour; in fog, some of it may be changed to sulfur trioxide and sulfuric acid mist.

Carbon monoxide is formed by incomplet combustion of any substance containing carbon--coal, petroleum products, natural gas, and even charcoal. Reference to the lethal effect of this gas is deemed unnecessary.

Hydrocarbons are compounds containing only hydrogen and carbon. There are four classes of hydrocarbons--paraffins, aromatics, naphthenes, and olefins. Hydrocarbons enter the atmosphere chiefly as unburned or partially burned gasoline from mot or vehicle exhaust; to a much smaller extent, in the refining, storage, and marketing of petroleum products, some may be lost and emitted into the air.

Aldehydes contain carbon, hydrogen and oxygen, and may be formed as a result of incomplete combustion or from the action of sunlight on nitrogen dioxide and olefinic hydrocarbons in the atmosphere. The Air Pollution Foundation have determined that acrolein and formaldehyde are the major eye irritants in Los Angeles' smog.

Acids are usually organic, containing carbon, hydrogen, and oxygen (but more oxygen than is contained in aldehydes), these are formed chiefly by incomplete combustion, although some are formed in certain industrial processes, and others by the "photochemical" process.

There are also gaseous inorganic acids, of which hydrogen fluoride is the most significant, being the only known toxic gas in the atmosphere that contains fluorine.

* * * *

Originally, man made his first efforts to combat air pollution because it was creating dirt and filth in his surroundings. The health aspect received little attention. However, three incidents occurred in rapid succession which focused attention on the potential health hazards, and convinced him that immediate improvement of his environment was imperative, if optimum opportunity for survival was to be maintained.

In 1930 a prolonged inversion imprisoned airborne wastes over the Meuse Valley in Belgium. Thousands of people became ill and 63 died. However, not too much enlightening research was done until 1948, when a similar inversion over Donora, Pennsylvania, a smelting town, caused sickness to 5,000 odd people, and the death of 20. In that same year an inversion at London, England, brought death in its wake to three hundred persons suffering from cardiac and respiratory diseases. This was a forerunner to a more serious occasion, which occurred in 1952, when a lung-searing pall of dirty gray air allegedly killed 4,000 Londoners.

Significant work has been accomplished in the elimination of some air pollution sources. Earlier, this was a matter of concern in unusual situations only; but population growth and concentration now give pollution control importance and urgency in practically every community. The ultimate answer is not a simple one. While our technical resources for diagnosis and prescription are greater than ever before, the multiplying diversity and complexity of human activities augur for much more comprehensive control work than ever before.

It is in the matter of control procedures which are adopted to affect corrections that the inter-relationship between air pollution and water pollution begins to become apparent.

For example:

- (a) Fume emissions from industrial plants are controlled by baghouses, electrical precipitators and sulphur recovery installations.
- (b) Dust emissions are reduced by baghouses, centrifugal air separators, electrical precipitators and water scrubbers.
- (c) Mist by fume burners, water scrubbers, sulphur recovery plants and vapour recovery systems.
- (d) Smoke by baghouses, electrical precipitators, catalytic combustion and better firing practices.
- (e) Nitrogen oxides from industrial plants are controlled by spray towers, venturi scrubbers or, in some cases, catalysts.
- (f) Sulphur dioxide in high concentrations is controlled by recovery plants but in low concentrations a feasible method of control is not available.
- (g) Carbon Monoxide is controlled by oxidizing it to carbon dioxide and by scrubbing.
- (h) Hydrocarbons are controlled by vapour recovery systems and venting to smokeless flares.
- (i) Aldehydes are controlled by vapour recovery systems and venting to smokeless flares.
- (j) Acids are intercepted by water scrubbers.

You will have noticed in the foregoing review of control techniques for the various pollutants that frequent reference was made to the utilization of venturi or water scrubbers. Tremendous amounts of water are used each year on this continent for these purposes and the waste water, in many instances containing high-acid content or deleterious compounds, is very often discharged without treatment. This source of surface water pollution will require increasing attention in the future as more controls are instituted. The effect of scrubber effluent on sewage

treatment plants has also been a matter of concern on frequent occasions, and there is evidence that plant efficiency has been disrupted.

In discussing the public health aspects of water pollution last year, Dr. A. E. Mastromatteo of the Ontario Department of Health cited an episode that occurred in Reichenstein where smelting fumes contaminated the drinking water supply. Numerous cases of chronic arsenic poisoning occurred in the inhabitants of the town. For many years the true nature of the disease was not known and it became known as Reichensteiner's Disease. When the cause was determined, a new town supply was secured. Apparently, the acid content of the fumes returned to the earth's surface with rainfall, or by settlement of the coarse particulate matter.

The Doctor also mentioned that the possibility of air pollutants settling to the ground and being washed into our water supply is more than academic. One air pollutant--in particular 3/4 benzpyrene--is known to produce cancer when painted on the skin of mice. It results from combustion products associated with coal, oil and gasoline and its return to the earth might be anticipated in a manner similar to the case quoted previously.

The Battersea Thermal Generating Station (London) provides an interesting study in the complexities of pollution control. At his installation the flue gas is washed with Thames River water to remove contaminants. The process removes 85% of the sulphur dioxide but certain disadvantages have been experienced. The cooling of the stack gases has reduced their upward velocity, thus reducing diffusion at height and contamination of the river has resulted from wasting of the wash waters.

Probably one of the most significant studies made on the impingement of air pollution on the quality of surface waters is to be found in the works of Eville Gorham and Alan G. Gordon, as described in the Canadian Journal of Botany, Volume 38 (1960) page 477, under the title "The Influence of Smelter Fumes upon the Chemical Composition of Lake Waters near Sudbury, Ontario, and upon surrounding Vegetation." This investigation was undertaken among other reasons to ascertain something of the influence of smelter pollution on lake waters in the area, and to examine the effects upon vegetation near the water surveyed.

Analyses for sulphate, calcium, and pH were made on surface waters from 102 lakes and ponds in the Sudbury metal-smelting district, and data presented for 35 of these. Sulphur pollution was found to be frequently high within 5 miles of the three smelters and many ponds exhibited more than three times the sulphate concentration normal for the area, with three waters more than ten times this level. About 15 miles distant, the influence of smelter pollution upon sulphate concentrations in surface waters was negligible, but many of the most polluted waters were strongly acid, with pH values going as low as 3.3. Sulphuric acid from air pollution was deemed to increase weathering of calcium from soils and rocks, so that this ion tended to rise in concentration not only in waters above pH6 but also in those below pH5.

During June 1959, 102 surface water samples were collected by helicopter and automobile from a wide variety of sites in the Sudbury area, in most cases from small and relatively undisturbed bodies of water with restricted local drainage. The samples were taken in pint polyethylene bottles and transported to Toronto for analysis within the next month. The data collected show very clearly the influence of air pollution in raising concentrations of sulphate in pond and lake waters near the smelter stacks.

This study indicates the extent of damage experienced. Its potential application in connection with the location of future smelters or similar industrial installations elsewhere will also be of interest. For example, should a new smelter be contemplated, then its location should be sufficiently far from residential and other community areas to preserve their amenities from pollution and damage.

Perhaps one final example might be in order. A stack emission carrying a high percentage of coloured particulate matter was causing extremely unpleasant conditions in the Toronto area recently. Eventually, it was determined a high efficiency venturi scrubber should be employed. This decision, however, was not taken until it was ascertained that the coloured waste water could be satisfactorily conditioned before discharge to the lake.

It is obvious that, as public opinion and consideration of the citizens' interest produce an intensification of air pollution control ordinances, there is the strong probability of an ever-increasing impingement on the work presently under way to control water pollution.

It would, therefore, be desirable to assess completely the nexus in the two disciplines and define the boundaries where there is a definite and ascertainable inter-relationship. It is in this area of "mutuality" that research and technical expertise could produce the most significant results.

Research on a broad scale is required--embracing geophysical, physical, and discussion at conferences by those associated with pollution control work in all its phases; also compilation and analysis of recorded data presently available. Referring to the geophysical, a study of the sulphur cycle would be of interest for, unlike oxygen, in nature it is not closed. Most of the excess sulphur in rivers can be said to be of anthropogenic origin, generated by industrial use of fossil fuels.

IN CONCLUSION

The contaminants which create air pollution have been discussed and the methods by which these contaminants are controlled in stack emissions have been assessed. The effect of the removed injurious materials on surface waters has been evaluated also. Axiomatically, air pollution control work will be intensified in the years to come. As mentioned, air pollution control activities must proceed hand in hand with the significant work under way in relation to protection of our surface water resources.

Contemplating the future, a few statistics will illustrate the magnitude of the problem; for example, in the year 1990, the following will be required every minute of every day on this continent:

23 million gallons of water - pure and sparkling
4.8 million pounds of clean air;
and combined with these necessities
 $\frac{1}{2}$ million pounds of refuse will have to be
destroyed; and
23 million gallons of sewage will have to be
treated.

To adequately handle these public works problems, conservation on a far broader scale than we know it to-day will be imperative, and the use of this word implies wise management of every resource, with the necessity to return them without impairment after utilization. Eventually --and the need is now--a new policy must be adopted, and the writer subscribes to Dean McLaughlin's statement last year in his paper "The Role of the Engineer", to the effect

that before embarking on any new process or procedure, the potential pollution arising therefrom must be determined and the cost of eliminating or preventing such pollution be incorporated in the charges for the product or service.

The writer has avoided reference in this paper to the effect of fallout on surface waters, since the subject forms the text of another paper being presented at this Conference.

Mr. Snider:

Many thanks for that very fine excellent paper. It has given us a great deal of food for thought. The relationship between air and water pollution certainly has been treated in a very comprehensive way. Now there will be a short period of discussion.

Mr. J. B. Wanko, Vice-President, Giffels and Vallet of Canada, Ltd., Windsor, Ontario;

Mr. Clark, I have a question regarding the contaminate you had not mentioned and that is the gasoline additives like tetra-ethyl-lead. Is there anything being done in that regard?

Mr. Clark:

I can't quote the specific reference, but it was in a technical journal, not more than seven weeks ago, that I read an article which said in effect--let us not worry too much about tetra-ethyl-lead in the air. There are many things that are worse. Let's get at those first. Now, that is giving you an analysis of what I recall I read.

Mr. Snider:

Any further questions?

Mr. T. B. Borgford, Canadian Industries Limited, Montreal, P.Q.;

I would like to mention that we have used cooling towers in a number of our plants up at Copper Cliff. There we have been able to maintain a quantity of water in the cooling system quite satisfactorily. There was a bit of a problem to start with, however. At another plant we have a cooling tower which has quite a problem with respect to air pollution. The contamination picked up by the cooling tower is quite severe and quite a problem to us. I might say that the problem hasn't yet been licked, but I thought I'd just draw this to your attention.

Mr. Clark:

Actually, in Metropolitan Toronto today, before we recommend what industries should do, and we don't say they must do it, but before we recommend what they should do, we invariably get around to suggest they put in water scrubbers. We want to know how they are going to intercept the contaminants in that water, before they discharge it to a nearby water course or sanitary sewer. If this cannot be done effectively, then we probably will recommend a different type of interception equipment to the industry for their air pollution control work. But what you explained was just another example of the interrelationship I was trying to develop today, and I thank you for it, sir.

Dr. Gustave Prevost, Chairman, Quebec Water Purification Board,
Montreal, P.Q.;

I might say that we certainly agree very heartily with your summary where you say that before any new industry proceeds with any building work, the plans and specifications showing how they are going to take care of pollution must and should be approved by a recognized authority. We are insisting that for water pollution and we are glad to know you feel the same way with regard to air pollution. That is an important thing.

Now, I would like to direct this question to Dr. Berry or Mr. Landis since Mr. Clark has shown that his quite close relationship with air pollution is the present legislation in Ontario authorizes the municipality to get in an industry and to have the equipment fixed or changed from that industry.

Dr. Berry:

Not yet, but that might come later.

Dr. Prevost:

Thank you. I hope we will have it in Quebec.

Mr. Snider:

Any further questions? If there are no further questions, we will proceed to our next paper. Our next paper, a very interesting paper indeed, on "Water Storage in Quality Management", by Mr. J.W. Murray, Hydraulic Engineer, Conservation and Parks Branch, Ontario Department of Commerce and Development. I am sure you will find this an exceedingly interesting paper.



WATER STORAGE FACILITIES

IN SOUTHERN ONTARIO

J. W. Murray

Hydraulic's Engineer, Conservation & Parks Branch
Department of Commerce & Development



This paper is limited to the water storage facilities developed by the Conservation Authorities in Ontario and those currently underway or planned for the future.

The Conservation Authorities are organized on a watershed basis and as such are natural units from the point of surface water management and control. In this way a fully integrated plan for control and use of the water resources can be prepared and carried out most effectively. Local planning and action by one or two municipalities in the long run often lead to waste of effort and do not provide the most satisfactory means of control or for the maximum use of the water available.

The water problems of our river basins may generally be grouped into two categories. The problems of hazard to life, property damage, erosion, etc., which are associated with excessive flows and those of pollution and water shortages for domestic use, agriculture, recreation, etc., due to low flow conditions. Thus, any plan for the control of the available water resources should of necessity consider these two aspects of the problem.

In the past, supplies of water in Ontario were considered unlimited. Flood control work was carried out on a local basis and usually consisted of channel improvements and dyking designed to get rid of the water as quickly as possible without any thought of conserving it for periods of drought.

We still have floods and up until recently the potential danger was increasing as encroachment on the flood plains continued. However, this has to some extent been remedied by the carrying out of flood control works and the restrictive zoning and acquisition of flood vulnerable areas.

Also concern is now being given to whether or not the areas inland from the Great Lakes, with their rapidly increasing populations, have sufficient water supplies to support their continued growth. We know of a number of industries which have threatened to move if the municipality where they are located could not supply them with more water.

In the Conservation Authorities' movement all schemes or projects must be initiated by the member municipalities through their local Authority. The Province does not tell them what they must do.

However, when an Authority is first established a survey is made of the area and a conservation report prepared for their guidance.

There are now 31 Conservation Authorities and the Grand River Conservation Commission in Ontario covering an area of more than 20,000 square miles. Reports with recommended plans for flood control and water conservation have been prepared for 20 of these areas and others are underway. In the past 15 years the Authorities have spent some \$20 million on flood control and water conservation projects. In some cases control by means of storage reservoirs is not practical and channel improvements have been carried out. Typical of these works are the Brampton diversion and the Guelph Channel Improvement schemes.

However, control by means of reservoirs which reduce the high spring flows by taking some of the excess water into storage for release later throughout the dry summer months has many advantages and is the method most commonly recommended and used.

In most watershed areas there is sufficient water for all foreseeable needs if the run-off is controlled and not allowed to go to waste. For example, on Big Creek, which drains most of Norfolk County, the centre of the tobacco growing industry in Ontario there is a problem of water supply for irrigation. Big Creek is not a large river and the area drained is 275 square miles yet in a period of a few days in March over 6 billion gallons of water go to waste. The water wasted during a normal spring break-up would supply the local tobacco growers for 13 years.

Similarly on the Grand River which is the largest river in south-western Ontario, recorded flows at the city of Brantford show that in a single flood in 1948 over 126 billion gallons of water passed down the river at this point. The city of Brantford takes its water supply from the river and at the present rate of consumption the volume of water which flowed passed the city in a few days during the 1948 flood was sufficient to last the city for 64 years.

These are not isolated cases but are typical of all the streams and rivers in the Province. Thus it becomes a matter of providing control to regulate this natural flow and conserve some of the large volumes of water which normally run to waste.

In the course of our studies we have carried out investigations which have indicated where reservoirs could be built. Most of these are long term plans the status of which may be summarized as follows:

1. Reservoirs which have been completed represent a total storage capacity of 168,470 ac.ft., (45 billion gallons) the major ones being Fanshawe on the Upper Thames, 40,000 ac.ft.; the Shand and Conestogo with 50,000 and 45,000 ac.ft., respectively and the Luther Marsh with 10,000 ac.ft., on the Grand Watershed.

2. Reservoirs currently underway and scheduled for completion over the next ten years include:

- (a) The Parkhill Creek Dam and Reservoir on the Ausable River at the Town of Parkhill (9,600 ac.ft.)
- (b) Five dams and reservoirs on the Upper Thames River to supplement the storage of the Fanshawe Reservoir, (72,280 ac.ft. excluding Fanshawe).
- (c) Fifteen dams and reservoirs in the Metropolitan Toronto region (81,320 ac.ft.)

These represent a total storage capacity of 215,000 ac.ft. at a cost of \$38,500,000.

3. Reservoir sites which have been investigated and are planned for the future represent a total storage capacity of 380,000 ac.ft. at a cost of \$49,500,000.

This program to be completed over a period of 20 to 25 years represents a total storage capacity of 860,000 ac.ft. at an estimate cost of \$88,000,000.

Most of these reservoirs would be basically for flood control but many would provide summer flow and some would retain permanent lakes from which water could be pumped as at Fanshawe.

In addition to these large reservoirs the Authorities have sponsored farm and community pond programs throughout the Province. Individually these ponds might not appear significant but considering that about 2,500 ponds have been built over the past 15 years under this plan, the total effect is substantial.

These smaller ponds fill a gap between the large downstream storages and the headwaters and like the large reservoirs store excess water which might otherwise be wasted.

A third and important phase of the water conservation program is the preservation of marshes and swamps in the headwater areas. Several such areas, namely; the Hay Swamp on the Ausable River; the Ellice Swamp on the Upper Thames River and the Luther Marsh on the Grand River have been acquired and are being retained in either their natural state or improved for water storage purposes. In the past many such areas have been cleared and drained for agricultural purposes which might better have been left in their natural state.

The Luther Marsh at the headwaters of the Grand River is a typical example. Over the years large sums of money were spent constructing drainage ditches and clearing the land. This was not successful and much of the land was abandoned.

The Grand River Conservation Commission recognized the potential of the area for water storage purposes and purchased the land. A low dam was constructed across the outlet several years ago and this area now supplies from 60 to 100 c.f.s. of flow per day as needed throughout the dry summer months.

Similarly there are numerous lakes throughout the Province which could be restored or improved to augment the water supplies of an area. Typical of these are the lakes in the Bruce Peninsula which were drained by the Cement Companies in the early part of this century for the extraction of marl and then abandoned. Several of these have been restored by the Sauble Valley Conservation Authority.

Also in the Napanee Watershed one dam has been constructed to increase the capacity of Second Depot Lake and others are planned for other lakes in the area.

This is briefly the picture of the existing water storage facilities throughout the Province and those that are underway or planned for the future by the Conservation Authorities. It is hoped that this program will substantially correct the flood problem of the Province and at the same time provide for the better utilization of our water resources.

Slides.

Mr. Snider:

Water storage is, of course, our second item on the guided discussions. We are going to try to gain a little time here by asking that the discussion period on Mr. Murray's paper be deferred until the discussion period on water storage.

We will proceed now to our next paper, and that is a paper by Mr. L.E. Owers, OWRC Executive Engineer, and Mr. F.J. Campbell, OWRC Project Control Officer. They are going to discuss "The Financing of Sewage and Waste Treatment". These gentlemen are very capable members of our staff, and have a great deal of knowledge on the subject they are going to discuss. Mr. Owers is first.

* * * * *



FINANCING OF SEWAGE & WASTE TREATMENT

Prepared by

L. E. Owers, P.Eng., Executive Engineer

and

F. J. Campbell, Projects Officer

Ontario Water Resources Commission

INTRODUCTION

The need of pollution control in protecting our water resources is well recognized, and progress in the Province of Ontario has been most encouraging. Expenditures involved in the construction and operation of sewage and waste treatment facilities are high, particularly where the treatment processes employed must be quite complex to satisfy conditions in the effluent receiving waters. Requirements for municipal financing, except as indicated in the following remarks, are contained in The Municipal Act and The Ontario Municipal Board Act.

The treatment of sanitary sewage is generally accepted as a municipal obligation and engineering studies include careful consideration of industrial requirements. Frequently, these are the subject of special agreements in view of the unusual volume or strength of wastes involved.

A number of financing methods are available. The first section of this paper deals with the capital expenditures involved, the second with the annual revenue to support such projects.

In Ontario, all financial obligations to be incurred by municipalities come under the supervision of the Ontario Municipal Board. This Board is charged with the responsibility of ruling on municipal expenditures based on the financial position of the municipality, particularly as reflected in local charges on the residents.

The Board's requirements must be fulfilled regardless of whether the municipality is proceeding independently or under agreement with the OWRC. In the latter instance, the Commission deals directly with the Board on behalf of the municipality.

SOURCES OF CAPITAL

Prepared by

L.E. Owers, P. Eng.,
Executive Engineer,
ONTARIO WATER RESOURCES COMMISSION



MUNICIPAL DEBENTURES

The most common method of raising capital is by the sale of municipal debentures. These are generally non-callable and the policy of the Ontario Municipal Board appears to be to limit the term to a maximum of twenty years. The interest rate will depend upon the nature of the issue and the credit position of the municipality. Sales are generally made through a broker or agent at the most advantageous price.

Normally, the debentures are in the form of serial bonds where interest and capital are blended in equal annual payments, or where fixed annual capital repayments are made with varying interest payments. In a few larger municipalities, projects are financed by the sinking fund method. This involves a fixed interest rate with the establishment of a fund which is invested in approved securities to equal the amount of the debt at the end of its term.

CAPITAL LEVY

Some large municipalities have placed an annual levy on the general assessment to apply to capital expenditures. By this means, borrowing for such purposes is reduced, which is advantageous to the credit position of the municipality.

WINTER WORKS SUBSIDY

As an incentive to municipalities to create work during the slack period in the construction industry, provision is made in the Province of Ontario for the sharing of labour costs by both the Federal and Provincial Governments during the winter months. Where a municipality

undertakes a project which would not normally be constructed during the winter, the Federal Government has agreed to pay 50% of the labour costs involved and the Provincial Government 25%.

Based on the opening of tenders on projects being handled by the Ontario Water Resources Commission on behalf of municipalities, the submission of comparable bids indicates that these grants are not necessarily reflected in lower cost to the municipalities. This can obviously be attributed to higher costs due to adverse working conditions in winter.

NHA LOANS

Under The National Housing Act, provision is made for loans by Central Mortgage & Housing Corporation to municipalities for the purpose of assisting in the construction or expansion of a sewage treatment project. This program is to assist in the elimination or prevention of water and soil pollution, and works eligible for Federal financing include sewage treatment plants or plant enlargements, and certain trunk collector sewers as defined by CMHC.

An application to the Corporation for a loan must be supported by information on an overall pollution control plan acceptable to the Provincial authority involved, together with Provincial approval of the project design. Financing must also be acceptable to Provincial authorities. Where a municipality contemplates a staged programme, commitments have been requested on the overall plan to ensure that treatment facilities in particular are included in the interest of pollution control.

The loan under The National Housing Act is limited to two-thirds of the cost of the eligible works. The terms may extend to a maximum of fifty years from the date of project completion, but this is subject to the approval of Provincial authorities. The interest rate will depend upon the Government's own borrowing rate which changes from time to time. At present, this is 5 1/8% per annum calculated semi-annually. It is required that regular payments of principle and interest must be made at least annually, and a loan or any part of it may be repaid in full at any time before the expiry of the term without penalty. The loan may be secured by municipal debentures or such other security as CMHC deems necessary to protect its interests.

The attractive feature of this financing under NHA is the provision for partial debt cancellation. Where a project is completed on or before March 31st, 1963, 25% of the loan and interest accrued during construction may be forgiven by CMHC. Provision is also made for a partial payment on this basis where construction is incomplete at this time.

SPECIAL AGREEMENTS WITH LAND DEVELOPERS & INDUSTRIES

In dealing with subdivisions, it is common practice for municipalities to expect land developers to pay for services outright. Therefore, where joint works are undertaken, agreements with land developers on cash payments reflect the extent of participation in the works.

Similarly, industries are frequently requested to make cash payments covering unusual waste loading. In this case, however, some adjustment is necessary to compensate for payments which will be made under the normal rate structure imposed by the municipality. There is a desire on the part of industries to draft agreements for financing over extended periods in order that the payments may be charged as operating expenses. Since this implies that the capital expenditure is backed by the credit of the municipality, this may present some complications in view of the municipal debt limitations imposed by the Ontario Municipal Board, unless consideration is given to the status of the company concerned.

CASH PREPAYMENTS

The risk in incurring a large capital debt can be reduced by arranging for a cash prepayment by individuals. This requires some care in ensuring that commitments obtained will be honoured when payment is requested. This procedure has been followed in a number of small municipalities where the financial position is unsound.

ONTARIO WATER RESOURCES COMMISSION FINANCING

Under The Ontario Water Resources Commission Act, money for sewage works projects is advanced by the Commission to municipalities at an interest rate which is the actual cost of money borrowed from the Province. Provision

is made for repayment by the municipality over an extended period, with the majority of Commission agreements being written for thirty year terms. The indebtedness of the Commission can be met by the sale of its own bonds which are guaranteed by the Province, or it can borrow directly, as it has to date, from the Provincial Treasurer, thereby gaining the advantage of borrowing on a large scale.

The terms of the Commission's agreements are quite flexible to suit municipal requirements and to take advantage of Winter Works Subsidies, NHA financing, and reduction of debt by cash prepayments. If requested, principle payments may be deferred up to a period of five years after the work is completed. The interest rate will vary each year, and each municipality under agreement with the Commission will pay the same interest rate based on the average of all Commission borrowing.

Where a number of municipalities or other parties are concerned with a single project, the agreement includes the allocation of costs based on the extent of individual participation. The services of the Commission are considered to be particularly attractive in providing for the administration of such joint projects.

The basis of all financial agreements between the municipalities and the Commission is that they shall pay to the Commission the actual cost of the debt and service rendered. A number of supervisory services provided by the Commission's engineering and administrative staff are not charged to the projects, whereas the wages of plant personnel only are charged as a direct operating expense.

Contracting municipalities are billed quarterly by the Commission. The debt retirement billing is based on a sinking fund administered by an investment committee including representatives from the Commission and the Treasury Board. The March billing of each year provides for adjustments to compensate for such variables as the rate of interest calculated as described previously.

ANNUAL RATES

Prepared by

F.J. Campbell,
Projects Officer,
ONTARIO WATER RESOURCES COMMISSION



INTRODUCTION

For a number of years following the completion of a project (depending on the period of financing) the municipality concerned must raise, in each year, sufficient funds to cover capital debt charges, and operating and maintenance costs. There are a number of statutes in force which give the municipality authority to impose and collect rates to meet such expenses.

RECOVERY OF CAPITAL COSTS

The authority to impose special rates with respect to the capital cost of a sewage works project is found mainly in The Local Improvement Act and in The Municipal Act.

(a) The Local Improvement Act:

Generally speaking, only gravity sewers are financed under The Local Improvement Act. Under this statute, part of the cost of the work is charged on a foot frontage basis to properties abutting directly on the sewers and the balance of the cost is borne by the corporation and included in the general tax rate or recovered by a special rate on a defined area. There is a section, however, which authorizes villages and townships to construct sewage treatment works and recover the annual cost by a special levy on a defined area of benefit.

(b) The Municipal Act:

Section 380 of The Municipal Act is used much more widely for imposing rates particularly with respect to trunk sewers, pumping facilities and treatment works.

The special charge for the recovery of capital costs under this section is called a sewer rate which must

be computed by one or any combination of the following:

1. A foot frontage rate on the lands that receive an immediate benefit from the work.
2. A foot frontage rate on the lands that received a deferred benefit from the work.
3. One or more acreage rates on the various areas of benefit.
4. A special charge related to the water bill. This can apply only to properties which are actually connected to the sewage works.
5. A mill rate on the assessed value of the lands in the greater area of benefit.

RECOVERY OF OPERATING AND MAINTENANCE COSTS

(a) The Local Improvement Act:

The section of The Local Improvement Act which authorizes the recovery of capital costs by an area levy also permits the imposition of a similar levy to recover operating and maintenance costs.

(b) The Municipal Act:

Here again The Municipal Act is in much wider use and provides for the imposition of sewage service rates on owners or occupants of land who use sewage works. The relevant subsections do not specify how the rates are to be computed except that they must be equitable and just.

The most common sewage service rate structure is established by imposing a charge on each user in direct proportion to his water bill. In most municipalities, the percentage surcharge is the same for all classes of users. In a few cases, the percentage varies depending on the nature and volume of use. This is particularly desirable for industries taking considerable amounts of water from the municipality and not returning all of it to the sanitary sewer system.

The next most common method is by establishing flat charges for the various classes of users. This is desirable only in a municipality where water is sold on the same basis.

A third method which has been used is to base the sewage service rate on the assessed value of each property connected to the system.

(c) The Ontario Water Resources Commission Act:

Where a project is constructed and operated by the Commission, the Municipality has the same powers to impose rates as if the project were being operated by the municipality. Furthermore, a sewage service rate under the Commission's Act covers not only operating costs, but also the annual payment to the Commission's reserve account for renewals and replacements. The reserve payment is deemed to be a capital cost item and as such may not be collected by a sewage service rate as defined in The Municipal Act.

SEWER RATES & SEWAGE SERVICE RATES

General:

It is interesting to note that a sewer rate is a single charge which may be computed by a combination of factors, such as frontage, acreage, water bill and assessed valuation.

Two frontage rates may be imposed, one of which is for immediate benefit on properties fronting or abutting directly on a sewer. If the sewer is over-sized to serve additional streets at a later date, the cost of over-sizing may be recovered by a lower frontage rate on the streets which will or may derive a benefit in the future. The imposition of a frontage rate for immediate benefit is quite common, but I know of no municipality where the frontage rate has been imposed because of a deferred benefit.

It is not yet common practice to include acreage in computing a sewer rate. One advantage of an acreage rate is that it is fixed for the period of the debt and can therefore be commuted for a payment in cash. This would not necessarily be true if the acreage rate were imposed in an area of deferred benefit which by definition could later become an area of immediate benefit. The right to commute can also be granted when a frontage rate is imposed for immediate benefit.

The water bill method is now in wide use throughout Ontario in the recovery of capital and more frequently operating costs. This is particularly true in the financing of treatment plants and sewage lagoons.

The final factor in the sewer rate structure is the mill rate which may be imposed on the assessed value of all lands in an area which derives or may derive benefit from a sewage project. In cities, towns, and villages, this is ordinarily on the entire municipality, but in townships, it is customary to restrict the mill rate levy to a defined sewer area. The mill rate is computed on "assessed value of the lands" rather than on the "rateable property" which includes business assessment.

Sewer rates and sewage service rates, regardless of the method of computation, may be collected yearly, half-yearly, quarterly, or bi-monthly, and the billing and collecting may be delegated by the Council to a public utilities commission or a local water board.

In practice, however, only rates based on the water bill are collected by such agencies. All other rates are usually collected by the corporation in the same manner as taxes.

Mr. Snider:

Thank you very much Mr. Owers and Mr. Campbell for your combined presentation on that excellent paper. Now, I am sure that somebody will want to ask questions in regard to these two papers.

Mr. P. Hill, Giffels & Vallet, Windsor;

I would like to ask Mr. Owers a question regarding the financing of sewage plants. In the case of a small municipality building a sewage plant in which say, approximately 30% of the load was directly from a local industry, did I understand you correctly to say it would be reasonable to expect the industry to pay cash for their portion of the plant, while the municipality could, say, borrow the remaining 70%?

Mr. Owers:

Well Mr. Hill, I am not prepared to say whether it is reasonable or not, but it is being done.

Mr. Hill:

This is a matter of mutual agreement then--there is not legal ties one way or the other.

Mr. Owers:

It is on the basis of special agreement, and this type of procedure is quite common where smaller municipalities are involved with a limited amount of credit. Now, if you have an industrial waste such as you referred to, which reflects itself in approximately 30% of the capital cost of treatment particularly, this is quite possibly a debt that would be over and above the municipality's credit, as set by the Municipal Board. Therefore, the municipality is forced if you like, to approach the company for a cash payment, or possibly, even more favourable terms such as a short term agreement covering say, a five or 10 year period rather than an extended 30-year period.

Mr. Hill:

Thank you! Could this same thing apply to a water treatment plant, with some possible compensation to industry of a lower rate whereby they could be excluded from the cost of interest to the municipality?

Mr. Owers:

Yes it can be. I am a little bit out of my field in water--I used to be engaged entirely in the sewage field. However, Dr. Berry says in a quiet voice that it is possible.

Mr. Hill:

Thank you very much.

Mr. Snider:

Are there any other questions?

Dr. Prevost:

If a municipality can get money at a cheaper rate than with the national housing project, can we borrow the money and then have benefit of the 33% return from them later on?

Mr. Owers:

I have reviewed this federal legislation and I would think not. I would think that this is a package deal offered under the National Housing Act, and that in order to go through with it you would have to take the whole thing.

Dr. Prevost:

I was wondering what the answer would be to the people in Ontario, because in Montreal, in Quebec, the answer was that it probably could be.

Mr. Owers:

I don't think it's a problem we are faced with, because I am reasonably sure no municipality can borrow money at 5-1/8% interest.

Dr. Prevost:

We have in Quebec. At Granby for instance, they don't need the money from the federal organization because they are going to have a cheaper rate interest. I was wondering what it would be in Ontario-- what would be done in Ontario.

Dr. Berry:

This sounds like a pitch for amalgamation.

Mr. Owers:

This sounds very interesting, indeed, when you can borrow money at a lower rate than federal or provincial money. We have some municipalities in Ontario which told us they could borrow money at a lower rate than we could lend it to them, and we, of course, have the provincial rate at actual cost. Some municipalities said that they had special rates where they could do that. Where that is the case, that is the place to borrow, without fail.

Mr. D. B. Redfern, Proctor & Redfern, Consulting Engineers, Toronto;

I think Mr. Owers has mentioned that in the Central Mortgage legislation it is possible for a municipality to discharge its borrowings at any period up to the term of agreement with no penalties, so would not it be a matter of arranging your borrowings through NHA and in a very short time rearrange your own financing, after you have arranged to get the subsidy then arrange your own financing, say within a month or, why not a week? This sounds like something Mr. Landis would have to answer because there might be a few legal problems.

Mr. Snider:

Thank you very much, Mr. Redfern, for your comment. Are there any other questions? If not, we are going to proceed with the guided discussions again. I am going to turn the meeting over now to Dr. Berry.

Dr. Berry:

Now ladies and gentlemen, we have quite a number of questions on that list. We have done three on the first discussion, "The Water Resources Needs of Ontario for the Future". The fourth part, "How can recreational uses of water in the future be satisfied and be coordinated with other uses?" is part of this overall program of water resources for the future, and we want to get some information on that. And we will go on with the next speaker, Mr. K. M. Mayall of the Ontario Department of Commerce and Development.

Mr. K. M. Mayall:

Mr. Chairman, ladies and gentlemen; I am not going to waste much of your time. I don't think we can forecast total needs of water because in the first place, the framing of the question didn't say how far ahead in the future, and in the second place, the population in Ontario in the last year or so has not risen as rapidly as expected in the Gordon Commission's report on economic prospects. The need for water for recreation has risen and is growing extremely rapidly, and more rapidly than the population has grown, due to increased leisure time and improved transportation and the huge increase of boat sales, and salesman-ship concerning boats for fishing and hunting.

All except one of the 77 Provincial Parks have water as an important recreational facility. I know that the Department of Lands and Forests has opened access to an enormous number of access points to water, right across Haliburton and Muskoka in the past two or three years, and as the need increases, parks will obviously be increased in these access points.

Approximately 4 million people during this year made use of the facilities provided by the Department of Lands and Forests and the Conservation Authorities of Ontario. I need only cite 600 thousand visitors at Rondeau Park, 300 thousand at Sibbald's Point and perhaps more significant still, 300 thousand at the Pinery, a new park; and 123 thousand at the new Darlington Park, near Oshawa, which gives you some idea of the kind of problem we are faced with. The Conservation Authority parks had nearly 2 million people, and almost all of the park use was connected with water.

I think, and perhaps Dr. Clark will bear me out, that there is a desperate shortage of marsh lands in Ontario. I know that there is some control of hunting in the Darlington, Presqu'ile, Holiday Beach and Rondeau areas, but at Long Point they have complete control and management of hunting, and the demand, as far as I can gather, is much greater than the supply. Here is a water resource that has to be explored.

The opening up of many of the new storage dams will certainly provide an improvement but it won't be anything like, as far as I can see, enough for the exploding population. I would envision private enterprise going ahead with a kind of scheme that some of you will not credit at all. At the crossroads of Highway 400 and Highway 7, there is a shallow pond which is run by a private enterprise. It is merely a place where they took aggregates for supplying roads and enormous numbers of people are flocking to this place, and making a fortune for the owners.

I think that probably the temperature of the streams is going up. The temperature of one of the streams on the Nottawasaga went up 20° last summer, when a pond was put on it, and that is a pretty notable increase, and wrecks it for speckled trout. There are going to be thousands and thousands more ponds. Irrigation is going to require innumerable new ponds, and I think that this will provide, in fact it is providing now, facilities for fishing, and will provide facilities for swimming also. But I think that one of the main things that we will see in the future will probably be the excavation, much cheaper than they are doing now, of areas down to the ground water which lies six or 12 feet below the surface of the ground in many parts of southern Ontario.

Dr. Berry:

Thank you Mr. Mayall. This is an important use of water in considering the water resources for the future. We would like to get full information and full views on this. Is Mr. Walkinshaw here?

Mr. D. R. Walkinshaw, Q.C., Roebuck & Walkinshaw, Barristers, Toronto;

Gentlemen; answering this question, I find myself in rather a peculiar position because recreational use of water has always been the forgotten child around this country. We have listened to industry say that it has to have billions of gallons on water per day; we listen to agriculture say it has to have trillions of gallons of water a day. By the time the industry and agriculture

are through, we are going to be sitting in a mud hole. There won't be any water left for us, so there won't be any recreation. Now, the one possible way that recreation can have its fair share of the water is for its share to be allocated to it, the same way that industry wants its share allocated and the same way that agriculture wants its share. We have got to, in this province, immediately set up some agency, whether it is the OWRC or some other agency, to survey the water needs of the province, to decide whose needs are paramount in each area, and to say how much water can be used by each one of the various users. If this is not done, we who want to drive our motor boats, or want to fish will find that all we've got is a mud hole in the summer time to do it in. The tourist industry today is becoming one of our major industries. The amount of money coming into this province is growing by leaps and bounds because of the good clean water that we supply for all recreational needs. We are faced right now with problems which must be solved, by, possibly, the OWRC.

What is remaining of water levels? I can tell about a situation which took place last fall up on one lake up north which has a big hydro dam on it. The water level in that lake was reduced so low last winter that the camp owners had to walk upwards of half a mile from the end of their docks to get their boats into the water. That is not recreation I admit--that is labor.

We have the same situation on the French River. The French River, as you all know, is one of our finest fishing and hunting rivers in the province. It has got an international reputation, and yet that water level will go up and down eight and 10 feet, spring and fall. You cannot have fish spawning in that type of water. You've got to maintain levels. Now, this situation and this problem has not been faced by the people in this province, and if we don't face it now, and if we don't set up some sort of a commission or a committee to regulate this, we can wipe out recreation for the future.

Dr. Berry:

Thank you, Mr. Walkinshaw. This is the very type of suggestion which I am sure we want to bring out in a conference of this kind. What are going to be the needs for the future, and what steps should be taken? This is an opportunity for each one to express his views here. I have another one listed on this, Dr. C.H.D. Clarke, Chief, Fish and Wildlife Branch, Department of Lands and Forests.

Dr. Clarke:

It is difficult to predict how future needs for recreational use of waters may be met because they are so closely linked with quality. Recreational values are inherent in almost all waters--for example, excursions on the Potomac, though people are warned not to touch it. The better the quality of the water, the greater its unit area value for recreation. Toronto has an abundance of water which is not meeting recreational needs because of low value.

Given an available supply of recreational values, their use is greatest near centres of population. A formula for use can be based on Newton's gravitational formula.

Recreational potential can be created by restoring water quality or creating either water areas or access. In this field, a study of recreational needs based on existing patterns of use can be completely wrong. In an arid area of the United States, such a study would have shown no knowledge of, or interest in, duck hunting, but the creation of a large marsh by impoundment created knowledge, interest, use and values.

There can be competition between recreational uses. In some small waters, fast boats and angling are incompatible and in one state hundreds of access sites, bought by earmarked angling licence money, are being used by recreationalists whose actions make angling impossible.

The important thing is to recognize that recreational values are present in all waters and must be identified, preserved, and enhanced. They must be weighed in planning and cost benefit analysis. Angling, for example, is indulged in by one-fifth of the people of Ontario and many tourists, who expend at least \$100 millions a year, a substantial value for only one form of recreational use.

Dr. Berry:

Thank you Dr. Clarke. Would someone else like to make a comment on recreational use of water?

Mr. A. M. Greenaway, Credit Valley Conservation Authority, Port Credit;

I think, Mr. Chairman and fellow delegates, that nearly every question on the floor today in connection with water got down to the fact that it all hooks in and joins in with conservation. There are, as you have heard a previous speaker say, 31 conservation authorities in this province, every one of them set up with the proper machinery to perform the job and function that it was created for. We who are directing the carrying-out of conservation programs throughout this province are much concerned about the present and future requirements of generations unborn, the same as the rest of you are. In recent years, the realization of what these requirements most certainly will be, have caused all of us to tighten our belts and become realistic in the sensible approach to the situation.

What our requirements will be 40 years from now would depend a great extent on what we do now. Every conservation authority in this province knows precisely what its function is and what its program is--to follow the long road home to rehabilitation, to offset the wasteful years when we used up so carelessly what nature so abundantly supplied. Water

is our lifeline, and must be our first concern. We impound it wherever possible for flood control and storage purposes, to be released as required to keep our summer flow at a proper level, to raise our water tables, and to provide agricultural and industrial and domestic uses with a more adequate and equitable share of what nature provides so freely.

We on the Credit have our plans formulated for a series of large control dams, and when these dams are completed, the Credit River will again be a river to be proud of. It will be able to provide a great supply of water for all types of consumer requirements. Pollution problems will be minimized and the whole conservation concept will be benefited. If the 31 conservation authorities can implement their water control programs, think of the fantastic amounts of water that can be saved for consumer use. If we save pennies and small change, we soon save dollars. The same thing applies to the billions of gallons of water we can save. We have to get a start, and I say that we should begin to make a start on what we are provided with already, which are the facilities to go ahead and begin impounding water, and at least get the water. Then we can decide what to do with it after we have it. An educational program, I believe, might be one way to create an interest in saving water, and that should start right from small school children. I think that angle should be pursued. Another thing is that it might be beneficial to the municipalities to, instead of giving a discount for the use of water, give a discount for the minimum use of it. Anything possible to start saving water would be the ideal situation to follow.

But conservation programs need money, and when you consider the cost of highway construction compared to the cost of some of these great projects we've got on hand, it seems to be, in my opinion, that the few millions of dollars we need for conservation and the selection of water should be equally important, if not more so, than a few miles of highway construction. Our first concern should be to start saving water. We can decide what to do with it after we once get it.

Dr. Berry:

Thank you Mr. Greenaway. You made a strong appeal for conservation, and that's what we are talking about. Would someone else like to say anything?

Mr. W. L. Rice, Chief of Civil Engineering, Department of Public Works, Toronto;

I would like to add an illustration of where a municipality uses dilution as an initial purity factor in its source of water supply, and storage, and also assists in recreational facilities.

The City of North Bay uses Trout Lake as a domestic water supply and reservoir, as well as for recreational purposes. Trout Lake has a comparatively small drainage area, and consequently small renewing sources. In order to keep a reasonable purity factor in the water by dilution, particularly in the summer time, the depth of water in the lake becomes critical to the extent of inches rather than the usual measurements in feet. In order to control the loss of lake levels and insure maximum dilution for an initial purity factor, a dam was constructed at the outlet of the lake. A few years ago flooding was threatened in the springtime, and some enterprising individual blew out the dam by dropping explosives from an aircraft, because the dam could not be reached at that time in any other way. When the floods had passed, the lake dropped too low, and the Medical Officer and others raised a hue and cry about excessive pollution of the lake reservoir because of inadequate dilution. Incidentally, the Department of Public Works had to speed up repair work on the dam in order to restore lake levels for required dilution.

I think it is safe to assume that recreation facilities add to the pollution of the lake, particularly if the lake level is allowed to go low. Keeping up the lake level, besides assisting in the quality of water for domestic consumption, helps to provide for greater recreational use.

Dr. Berry:

Thank you, Mr. Rice. Now, I think we will have to go on to the next question, "To what extent must dilution be made available for carrying away waste effluents in the future as the population increases and industry expands?" The thought behind that is--is it going to be necessary to construct dams and to carry out measures of that kind in order to provide more dilution? The first on the list here is Dr. Stuart of Hamilton.

Dr. L. M. Stuart, Director & Medical Officer of Health, Wentworth County Health Unit, Hamilton;

As a mere M.O.H., I think I'm kind of out of my league with all these high powered engineers and authorities. I just seem something like a little leaguer who has suddenly been called on to play shortstop in the world series.

We heard a lot about industrial, recreational and other uses of water, but as a health officer, I think perhaps some of our attention might revert again to the people, certainly a great component in industry and it is people who are going to enjoy recreation. This problem of dilution is certainly becoming more and more something to think about.

I had the pleasure or good fortune to be brought up in two communities that were predominantly inhabited by Scots or people of Scot's origin, and became exposed to many, many sayings they had, and, having that sort of a mind, this one sort of stuck in it. An expression that every mickle makes a muckle, as the old lady said when she lictorated in the ocean. Now, the ocean undoubtedly is sufficient to look after dilution problems there, but as our population is increasing, these mickles have reached astounding muckles. So it's rather alarming when you see a beautiful river polluted. We don't use it for anything, it's gone. Then you can come down to a little different level and wander around in your municipality, urban, semi-urban, and rural, and some ditch has unfortunately been used for disposal of sewage, but it doesn't run all season. For a while, the dilution is all right, but you can see evidence that it wasn't enough.

We have these problems contributing to pollution all through our communities in every different locality, and we know that if these things are taken in hand by properly looking after these things that, we can, from a well-conducted sewage disposal plant, return effluent into receiving streams that is possibly of better quality than the water which receives it. With this talk of industry and its huge uses of water, I think we must bear in mind always that we have to make the proper amounts of water available for this extremely important function of dilution in looking after the accumulation of human sewage which is bound to be increasing with the explosive increase in our population.

Dr. Berry:

Well, Doctor, in spite of what you say as little leaguer, I regard you as a great big leaguer in the health field, and you are doing a very fine job as health officer. Dr. Prevost, we would like to hear what you have to say.

Dr. Gustave Prevost, Chairman, Quebec Water Purification Board,
Montreal;

People have said before that they need millions of gallons of water a day, trillions of gallons of water a day, for all kinds of purposes. Well, I can tell you that we in Quebec have the answer. In your mind, you will say, "Oh, those Quebecers! Are they so different from the others?" Don't tell me that you have the answer, if that's what you're thinking. Well, I should say that no dilution should be considered in the future. Does that mean we're going to throw everything in the water without looking after dilution? You know how we stand in Quebec? We don't consider dilution or chlorination in our policies.

When I say the lead will come from Quebec, that is not true. But it will come from the United States, and here I would like to read from a report on the future prospects, by a great authority like Dr. Gabrielson. Techniques are now available which can be universally used, and which would virtually eliminate dangerous contamination from the streams and rivers. Within 25 or 30 years at the most, techniques now being developed will result in the economical removal of all dissolved materials, producing completely pure water effluent from sewage plants. And now it has been shown, for instance, in the making of fresh water out of salt water, the cost has been reduced to 30¢ per 1,000 gallons of water. In many industries it costs about 20¢ per 1,000 gallons of water.

So, it's quite near, since already they have that, and with nuclear energy, which can of course cause other trouble with radio-activity. On the other hand, if we have a lot of power we won't have any shortage of water, because such water can be reused by pumping and so on.

However, more research has to be done very, very soon. As a matter of fact, we are late with it. We spend many millions of dollars to try to reach the moon. Why shouldn't we spend a few million dollars to get pure water, and reuse that water? Because the sky won't give us more water; we absolutely need to have good ways of treating water and reusing it 100%. Dr. Gabrielson and others say it is intolerable for the United States with its high state of civilization and wealth to permit polluting wastes to be dumped into its natural waterways any longer.

With the new treatment, there will be adequate water for all reasonable purposes without the necessity for constructing huge impoundments, and destroying the natural environment of our waterways. I know the conservationists don't agree very much with the engineers on that, but it has been proven in many cases that dams are no good at all. Silt comes in and in a few years time the water is no good. It's all right in the higher watersheds, as mentioned, but we have to be very careful before we build a dam.

Does a country wish to build a future completely and ruthlessly devoid of nature? Do we really mean to crowd back nature to the utmost minimum depending upon ingenious emphasis of every term for physical and spiritual suffering, until we have to eat standing up? And the healing which comes of water survives only in drains. So I think this shows you that for partial treatment, we don't believe in it. Of course, we have to use it now-a-days, no doubt. There is no doubt that we have to use it, but in Quebec our complete treatment will have to use all the mechanical ways and biological ways that we know before we can use the water over again after treating the wastes.

Dr. Berry:

Thank you, Doctor. One thing I am wondering about which Mr. Grandfield spoke about this morning--I think he was referring to the economics. He wants to sell water. Now, if all this treatment takes place, I presume it can be done at the moment, and we will use it right over again so we won't need to bring any water in. Now, Mr. Grandfield would not like that. Is Mr. Moro of Toronto here?

Mr. S. B. Moro, Project Manager, Shell Oil Company of Canada, Limited,
Toronto;

The objectives of water pollution abatement are to safeguard the water quality of the receiving waters. Receiving waters should be made to provide for the beneficial use of the type of society served and consistent with the variability within and among the different water basins. These current objectives in our opinion are equally applicable to the future. The extent to which dilution should be made available, therefore, depends on the primary beneficial use of the receiving waters and its assimilating capacity. Dilution should be used only for localizing the area of reduced water quality in the receiving waters with high assimilating capacity. No dilution should be used in receiving streams with minimum assimilating capacity. We would conclude that expansion in industry and population would require greater re-use of the receiving waters, and consequently a greater reduction in the use of dilution water.

Dr. Berry:

The conclusion there is not to offset treatment, but merely aid in it. Now, this winds up the first part of the guided discussion on "The Water Resources Needs of Ontario for the Future". Is there any discussion on Mr. Murray's paper itself before we close off for luncheon?

Mr. John Neil, OWRC Biologist;

I would like to make reference to Mr. Hore's remarks this morning concerning nutrients supplied from agriculture. When figures are quoted in fractions of pounds per acre they are seemingly unimportant but in water pollution we deal in parts per million or even parts per billion, and when a watercourse drains hundreds or thousands of acres, very small percentage losses become highly significant. To illustrate the effect of agricultural drainage on nutrient concentrations in streams, I would like to quote from a paper by Dr. R. O. Sylvester presented to the "Seminar on Algae and Metropolitan Wastes" United States Public Health Service 1960; streams from forested areas, little habitation use, total phosphorous 69 ppb, subsurface irrigation flow streams 216, nitrates 130 ppb as nitrogen in streams from forested areas and in the subsurface drainage area 2,690 ppb. A number of other studies with similar findings are in the literature. I think there is a strong indication of a relationship between agricultural drainage and the fertility in water.

Dr. Berry:

That's very interesting and provides an argument which is very good. Both sides are quoting authorities, but whether those authorities are any good or not remains to be seen. It looks as if both sides would have to go out and do some of this themselves.

Mr. Chairman, I turn the meeting back to you.

Mr. Snider:

Gentlemen, we have come to the end of our morning session and I wish to thank you for your close attention to the proceedings and the interest you have displayed. Our lunch will now be served in the next room.

CONFERENCE LUNCHEON ADDRESS

WATER MANAGEMENT
IN THE METROPOLITAN TORONTO REGION

Dr. G. Ross Lord, P.Eng.
Department of Mechanical Engineering
University of Toronto



King Edward Sheraton Hotel

Toronto

Wednesday, November 22, 1961

Water Management is an important part of the work of Conservation Authorities in Ontario. At the recent conference on "Resources for Tomorrow", held at Montreal, I was struck by the fact that many people in Canada and some in Ontario do not understand the functions and jurisdiction of a Conservation Authority in this province. So, in order to place my discussion in a proper setting, a minute or two will be taken to outline the powers and fields of activity of a Conservation Authority.

Conservation Authorities in Ontario are formed under the Conservation Authorities Act which was first enacted in 1946 and subsequently amended several times. There are now thirty-one Authorities established, with a total membership of 440 municipalities covering some 20,000 square miles of the Province. Authorities are constituted on a watershed basis and every Authority is a body corporate.

The Metropolitan Toronto and Region Conservation Authority encompasses 1000 square miles, including and extending beyond the limits of Metropolitan Toronto (250 square miles). It is an amalgamation of four former Authorities - the Humber, Etobicoke-Mimico, Don and R.D.H.P. (Rouge, Duffin, Highland and Petticoat). The Region covers all of the watersheds of the rivers and creeks which flow through Metropolitan Toronto.

The members of the Authority are chosen by the twenty-three municipalities involved. There are fifty-seven members, twenty-seven appointed by Metropolitan Toronto, twenty-seven by the other municipalities and three by the Lieutenant-Governor-in-Council.

The financing of the Authority is, in general, 50% by the Province of Ontario and 50% by the municipalities. The ordinary budget of the Metro Authority has been running in the neighbourhood of $1\frac{1}{2}$ millions per year. In addition, the Authority will be spending 3 to 4 millions per year on flood control schemes for the next ten years. Flood control schemes are financed, in general, by contributions of $37\frac{1}{2}\%$ by each of the Governments of Canada and Ontario and 25% by the Authority.

The Authority staff varies from one hundred in the winter to one hundred and eighty in the summer. The water management work is carried out by the permanent staff.

Matters of policy concerning water management are generally considered by nine Advisory Boards. There are four watershed Advisory Boards (Don, Humber, Etobicoke-Mimico and R.D.H.P.) which consider matters peculiar to the individual rivers.

Five functional Advisory Boards deal with many aspects of the water management problem.

CONSERVATION AREAS ADVISORY BOARD

The Authority now operates nine Conservation Areas: Boyd, Heart Lake, Albion, Glen Haffy, Greenwood, Clarmont, Cold Creek, Humber Trails and Black Creek. A common characteristic of these Areas is generally a stretch of river, rolling hills and valley lands and, in many cases, natural or artificial ponds or lakes.

Wherever feasible, the lake area is developed for swimming and recreation. Fishing is encouraged and the stocking of streams is a continuing work of the Authority. The Albion Hills Area provides an excellent example where a beautiful artificial lake has been created by the construction of a small dam. In one Area, trout ponds have been built and in another a natural swamp is being maintained in its primitive state. Almost 5000 acres are now held in conservation areas and public attendance reached 875,000 persons in 1961.

LAND USE AND REFORESTATION

The work of this board is intimately associated with water management at its source, which is on the land. Proper farming methods, such as strip cropping, contour ploughing, grassed waterways and tiling of wet lands, are promoted. In addition, the establishment of hundreds of farm ponds has been encouraged through the supply of technical advice and the payment of a subsidy for each properly constructed pond.

The Authority also takes part in reforestation through the annual planting of 500,000 trees. Over 75% of these are planted on privately owned lands. The effectiveness of adequate tree cover in promoting healthy water conservation has long been recognized. The protection of source areas by this means helps to reduce pollution and maintain enhanced summer flows in the area streams. The Authority has some 1800 acres of reforestation lands under agreement with the Department of Lands and Forests.

INFORMATION AND EDUCATION

No plan of water management can succeed without the backing of a properly informed public. The Authority has taken special pains to acquaint young people, particularly, with the problems and challenges of the proper use of water and all natural resources. Conservation camp schools are held and school essay contests on conservation are fostered. It is hoped that a permanent Conservation School will be constructed in the near future.

HISTORIC SITES

Many of you may know that the Authority is developing a Pioneer Village at Jane Street and Steeles Avenue in Metropolitan Toronto. This will be a pre-Confederation crossroads village with buildings equipped with furniture and utensils of the times. Even here, water management plays a part. These fine old wooden structures present a fire hazard of unusual gravity. A fire would destroy priceless relics of irreplaceable value. Therefore, the Authority has provided a substantial farm pond, which presents not only an aesthetic aspect, but is also constantly present for fire-fighting purposes.

FLOOD AND POLLUTION CONTROL

The flood control problem is especially important in the southern part of the Province of Ontario. The rivers here are numerous and generally not long. Many are less than ten miles and few over 200 miles in length. They drain either into one of the Great Lakes or into tributary lakes and rivers of these lakes. The watersheds range from 50 to 2200 square miles in area. These are small, indeed, when compared with the large watersheds tributary to the Mississippi River in the United States. However, due to special topographical features and heavy concentrations of population and industry in these areas, flooding has become a serious problem.

Unfortunately, early settlement took place very near the rivers, which were the principal means of transportation and sources of power. Buildings and industries were also often developed on actual flood plain lands.

In the Toronto region, flooding has always given trouble. However, it took Hurrican Hazel to convince the people that adequate flood control measures were needed now.

The devastation caused by Hazel will not soon be forgotten. The death toll by drowning was 81; 1868 families were left homeless and property damage approaching 24 millions of dollars was suffered.

Any system of flood control must be designed to fit the conditions in a given area. Around Toronto the rivers are short, ranging from 20 to 50 miles in length. At the same time, the gradients are steep. For example, the Humber River falls a total of 1200 feet in its 50 mile course from headwaters to Lake Ontario. Many of the valleys are well defined with steep banks and frequently flooded plains. Increasing urbanization has resulted in a more rapid run-off and faster concentration of flows at downstream points on the streams.

The steep gradients of the rivers result in relatively large amounts of hydraulic power being developed during flood run-offs. This power manifests itself in very high flow velocities which have unbelievable destructive power. On the Humber River, during Hurricane Hazel, the flow reached a maximum of 55,000 cubic feet per second, resulting in a generation of between one and two million hydraulic horsepower. This power was dissipated in tearing out bridges, excavating new channels, carrying away houses, disrupting services and generally creating havoc.

FLOOD CONTROL PLAN

The Authority is now in process of implementing a flood Control and Water Conservation Plan. The plan calls for the expenditure of 38 millions of dollars over a ten year period. It has been approved by all levels of government. Financing will be, in general, 37½ percent by each of the Governments of Canada and of Ontario and 25% by the municipalities.

The plan calls for the construction of 16 flood and water control dams, certain channel improvements and the acquisition of 7200 acres of flood plain lands. Many of the dams will have permanent lakes which will be available for recreational purposes. The net effect of impounding water will also be to increase the summer flows in the rivers and thus contribute to the dilution of any pollutants which may reach them. The Authority is, of course, greatly concerned about the possible effects of effluents from any sewage disposal plants which may be proposed on the upper reaches of its rivers. We are pleased to know, from recent conferences with the Ontario Water

Resources Commission, that they share our concern in this regard and we are assured of their support in our endeavours to keep pollution to a minimum. The pollutions described above are especially serious when it is planned to permit them to enter the river at points above reservoirs where swimming is planned as a recreational use. Of course, a secondary benefit from permanent reservoirs would be as an emergency source of water, should such an unhappy necessity occur.

It may be seen from these remarks that water management runs through the entire program of a conservation authority. In fact, the proper conservation and management of water resources will add immeasurably to the health and happiness of all of the people in a river valley for all time.

Wednesday, November 22, 1961

Afternoon Session

King Edward Hotel, Fountain Court

* * * * *

Mr. Snider:

As we open this afternoon's session, there still remains some of the question period, and I am going to ask Dr. Berry to take charge again.

Dr. Berry:

When we called on the guided discussion this morning, on the subject "How can recreational uses of water in the future be satisfied and be coordinated with other uses", Mr. Eric Baker was out, but I see him in the room now, and we won't let him escape this time.

Mr. Eric W. Baker, F.L.M.I., Canada Life Assurance Company, Toronto;

Our topic deals with the coordination of recreation uses with other types of water use. I will comment briefly on the elements of coordination, a tool for coordination and some examples of coordination in this field.

Coordination is needed to blend the specialist knowledge of various professions and also to straddle jurisdictional limits of various units of government as well as to select the best combination of methods in multi-purpose projects.

The coordinating team may include:

The engineer who is familiar with the feasibility studies for single purpose projects.

The biologist and the geographer who take account of side-effects as well as target effects.

The economist who evaluates alternative methods and their effects.

The planner (of any professional origin) who tries to bridge jurisdictional boundaries to fit the best methods into one integrated scheme.

The lawyer who filters out harmful repercussions.

Then the politician who adjusts the program to current public opinion and tax availability.

Probably a satisfactory job could be done by any one of these if he had the time to investigate objectively all the factors and principles involved but Canadian experience warns against this.

At the Provincial level coordination is being done by interdepartmental committees, by conferences such as this and by giving coordinating powers to bodies such as OWRC.

At the Municipal level this is not readily possible as most municipalities have only one professionally trained officer in the resources management field, usually a civil engineer.

To make coordination practicable I therefore suggest:

1. The Province should extend its advisory services to municipalities to include economists, geographers and biologists.
2. Municipalities should include their engineer in the decision making process wherever engineering aspects or alternatives may be present even though his department is not involved.
3. The municipal engineer should ensure that non-engineering aspects or alternatives are adequately explored in connection with his own reports even when it appears to be strictly a-departmental matter.

Wherever project coordination or evaluation is required, (and particularly in multi-purpose projects) the decision-maker can use the technique of Benefit-Cost analysis to advantage if the principles and methods proven by experience are followed.

The Guide book coming out of the Resources for Tomorrow Conference will be helpful but there may still be a temptation to class as intangibles those factors which are difficult to measure. Such difficulties often arise from an attempt to measure purpose rather than method.

For example, there is no point in putting a value on human lives protected, we should appraise the alternative methods of effectively protecting life.

Similarly, the abstract values of green belts and clean water are less important to the public decision maker than the alternative costs of obtaining them. For example, the theoretical value of \$25,000 per acre attributed to recreation lakes in the Metro Toronto Flood Control Plan is less important to the taxpayer than the fact that natural lakes can be bought for less than \$1,000 per acre. Where, in fact, artificial lakes can be created for less money by coordinating with some other purpose such as flood damage control or irrigation supply, that is important.

To illustrate the need for recognizing various professional disciplines the alternatives in flood damage control (erroneously labelled flood control) include:

1. protection, an engineering remedy.
2. flood-proofing, an architectural remedy.
3. floodway clearance by easement, a planning remedy.
4. national disaster funding, a fiscal remedy.

Examples of coordination of recreation uses with other uses include the artificial reservoirs created in connection with water supply, stream flow regulation, power production, navigation and flood damage control. However, it may be noted that some of these uses cause wide variation in water level which is antagonistic to recreation benefits.

It may also be noted that the shore line is the focus of recreation uses so a stream or a shallow lake with islands can have high recreation values even though it has low water volumes.

Probably the smaller headwater lakes can combine high recreation values with high aquifer charges for ground water supply.

In forecasting the future it seems reasonable to expect the Provincial Government to recognize more directly the public demand for recreation sites. So long as recreation lakes can be purchased only in connection with dams we risk paying fetish tribute to expensive concrete white elephants.

Another prospect of coordination with recreation lies in the multi-purpose planning and control of gravel pits, sanitary land fill, sludge disposal and park development.

However, as evident from the excellent paper on algae control nature herself is a very capable coordinator. We cannot afford to lose her partnership help and I suggest we should study our whole human ecology more carefully so we can more effectively accentuate the positive while eliminating the negative in natural conditions.

No man can know everything, but our mistakes of poor judgment or prejudice should remind us of the constant need for a system for coordinating enough facts and viewpoints.

Dr. Berry:

Thank you very much. Now to continue with our papers. The next one, "Industrial Waste By-laws For Municipalities", by Mr. Caverly and Mr. Harris, which, I believe is to be presented by Mr. Harris.



INDUSTRIAL WASTE BY-LAWS FOR MUNICIPALITIES

PRACTICAL AND THEORETICAL ASPECTS

D. S. Caverly, Assistant General Manager

and

A. J. Harris, Assistant Director of Laboratories

Ontario Water Resources Commission

presented by

Mr. Harris



This paper on Industrial Waste By-Laws for Municipalities, considers the practical viewpoint from the broad experiences of Mr. Caverly of the Ontario Water Resources Commission Division of Operations and the theoretical aspects of an actual model by-law which has evolved through consultations with municipalities, particularly the Metropolitan Toronto Works Department, from discussion with industries and from the Manual of Practice Number 3 on Municipal Sewer Ordinances prepared by the Water Pollution Control Federation.

Like many other excellent bits of advice, guidance on rational methods of control or industrial wastes to sewers may sometimes exist only to be ignored. Not that the average person displays no interest in the methods of control. On the contrary; frequently enough, they are but too eager to obtain information on the subject. So before proceeding to present some rules and regulations of effective industrial waste control, we must mention the condition of adhering to these rules. Firstly, there must be enough determination and perseverance to apply the regulations. Temptation to circumvent may arise from a desire to attract new industry or to accommodate on existing industry. Secondly, the regulating bodies must be capable of adapting regulations to the given set of rules which may involve various internal and external obstacles. That is, it should not be a case of simply memorizing the sections and applying them verbatim. A photographic reflection is not intended. The material must be digested, with the unnecessary details eliminated, and the main points interpreted freely and intelligently by the regulating power.

This ordinance, quoted today, is presently in a tentative form, open to suggestions and does not yet include concentration limits of radio-activity, for such items as Radium 226, Strontium 90, or Gross beta activity, or surfactants, nitrogens, tannin, lignin, odour thresholds or turbidity. Nor does it deal with financing or the establishment of rental or service charges.

With the continuing growth of populations, industrial expansion, and manufacturing of synthetic chemical compounds, there is a need for setting safe and acceptable limits for new impurities being discharged to watercourses and sewers. A sound sewer ordinance is beneficial to industry as well as the municipality, for it makes possible maximum use of the public facilities for all wastes that can be handled effectively.

Sewer ordinances are broad in their range. They can be prepared for any set conditions so that specific start can be limited or controlled. Those not producing problems can be left alone.

There are two reasons for applying sewer ordinances:

1. To limit and control -strength
-quantity
-character of industrial wastes
in order to protect facilities
or to avoid interferences with
operations.
2. As a base for applying sewage treatment charges -
In this case a provision will
be made in the ordinance to
evaluate flow and strength for
an industry.

The majority of the Ontario Water Resources Commission operated sewage treatment plants have had no difficulties with industrial wastes and can consistently produce high purification day in and day out.

There are a few however where operational difficulties, odours and high sludge handling costs are a direct result of uncontrolled discharge of industrial wastes. There are various reasons. In some cases a large industry with a heavy waste loading may be located in a small municipality. A municipality may be reluctant to pass or enforce industrial waste regulations. Some of the plants are upset when heavy loads are received, from such seasonal operations as canning, during the critical warm weather periods. I think the most difficult wastes encountered are those with high organic content such as chicken-killing, packing plant, tanneries and canneries. Loads from these types of industries have been reaching Ontario Water Resources Commission sewage plants three in five times as strong as what is normally considered the maximum treatable organic load. In addition, sludge accumulates too rapidly to primary sedimentation tanks and digesters are overloaded. Expensive sludge hauling operations are necessary which amount to a subsidy to the industry.

Another waste found difficult to handle in Ontario Water Resources Commission plants is caustic. In one outstanding case the pH at the sewage plant reaches as high as twelve during batch discharges of caustic cleaner from an industry. A pH of 8.4 is considered the optimum. Here

the municipality is compromising an investment of almost a million dollars because of their reluctance to put into effect industrial waste regulations which would control the alkalinity.

Odours from sewage treatment plants usually receive much publicity and the local people are quite justified in their complaints. With a by-law to regulate the strength of industrial waste and normal operating procedures, there is no reason for odours. Three localities having Ontario Water Resources Commission sewage plants have encountered occasional odour problems and in each case the cause has been proved to be the excessive strength of an industrial waste.

Oil, usually of the fuel type, has upset treatment facilities. The only cure is to pump the oil collected on the surface of the liquid from tanks and chambers. Although this has been a problem only at one small Ontario Water Resources Commission treatment plant, there have been numerous cases of bunker C fuel oil completely covering the liquid surfaces of tanks and chambers of municipal plants.

Proceeding now to the form of a by-law, it is usual to provide one for sanitary and one for storm sewers. I will deal now with sanitary sewer regulations but because of the time involved, will eliminate such contents as the introduction, definition of terms, provision of powers and authorities of inspectors, enforcement, validity and enacting clauses.

That part of an ordinance dealing with regulations relating to quantities and characters of waters or wastes admissible to public sanitary sewers reads as follows:

USE OF PUBLIC SANITARY SEWERS

Section 1

No person shall discharge or cause to be discharged any cooling water or unpolluted industrial process waters to any sanitary sewer. Such waters may be discharged, upon the approval of the Town Engineer to a storm sewer, combined sewer or natural outlet.

This section will prevent dilution of a waste to meet the requirements and also help to prevent hydraulic overloading of a sewage plant.

Section 2

No person shall discharge or cause to discharge any of the following waters or wastes to any public sewer:

(a) Liquid or vapour having a temperature higher than (150°F.)

This is primarily to protect sewers from thermal stresses and to protect the jointing materials. High temperatures will also increase the activity of bacteria and odours may result.

(b) Ashes, cinders, sand, earth, mud, straw, metal, glue, glass, pigments, rags, textiles, tar, plastics, cellulose, wood and wood products, or other substances capable of causing obstruction to flow in sewers.

These materials are all heavy ~~solids~~ which need never enter the sewer and should be disposed to a dump.

(c) Animal wastes such as hair, wool, fur, feathers, intestines, stomach casings, paunch manure, hides, hooves, horns, bones and fleshings.

These materials result from operation of packing-houses, chicken killing plants and tanneries. They can obstruct sewers, add a heavy BOD and solids load and create odours. They pass right through a treatment plant to cause unsightly conditions in the receiving watercourse.

(d) Waters or wastes which may contain any volatile oils of more than (100) parts per million of fat, oil or grease of animal or vegetable origin or (10) parts per million of oil or grease of mineral origin.

Quite often fats and grease are discharged in hot liquids from cookers or rendering vats or from truck or railroad engine crankcases. This may harden to a solid or congeal when cooled in the sewers and will pick up sand and other inorganic solids to form balls of grease. They float through the sewage plant or coat the sides of the tanks. Grease also is high in oxygen demand and will overload oxidation processes. Oils will reduce aeration efficiency by forming a film over the liquid.

(e) Waters or wastes which have a 5-day BOD greater than (300) parts per million and a suspended solids concentration greater than (350) parts per million

These values are normal to fairly strong sanitary sewage. They are not too restrictive. Aeration systems can only transfer so much oxygen to satisfy an oxygen demand

of a waste, that is, the oxygen required to chemical oxidation of nitrogenous and organic matter or for respiration of the bacteria. Overloading will reduce the degree of biochemical oxygen demand removal or may even turn the aeration chamber septic.

If a plant is underloaded there is little need to enforce a BOD regulation since sometimes an underloaded plant does not have sufficient nutrients to provide good biological treatment. Again if only primary treatment is provided, this regulation should be strictly enforced or made even more restrictive.

Solids over 350 ppm can clog sewers or screens and interfere with primary equipment and may overload the digester facilities.

(f) Waters or wastes having a pH lower than (5.5) or higher than (9.5) and not remaining within these limits on dilution or having any other property capable of causing damage or hazard to structures, equipment or persons.

The pH value is a number used to express the concentration of ionized hydrogen in an aqueous liquid and is thus indicative of the reaction of that liquid, that is, the neutrality or the degree of acidity or alkalinity. Free acidity is present below a pH of about $4\frac{1}{2}$ and caustic alkalinity above a pH of 8.6. When the concentration of hydroxyl ions is balanced by an equal concentration of hydrogen ions then the liquid is neutral and the pH is 7. Acids and strong caustics are detrimental to sewage treatment. Acids will corrode concrete, causing foaming in digesters, and may generate hydrogen sulphide. Strong caustic alkalinity is also corrosive to concrete, toxic to the biological process and results in heavy sludge deposits.

(g) Gasoline, benzene, naphtha, fuel oil, acetone, solvents or other inflammable or explosive liquid, solid or gas.

These materials are very seldom deliberately discharged to sewers since injury to life may result. Safety measures such as alarms, gravity separation traps, normally closed valves and similar safe guards should be agreed upon between industry and the municipality.

(h) Waters or wastes containing a toxic or poisonous substance in sufficient quantity to injure or interfere with any sewage treatment process or constitute a hazard to humans or animals. Included in this category are waters or wastes containing metals or chemicals such as cyanide, hexavalent

chromium, phenola, or copper whose concentrations are more than:

Chromium as Cr (hexa)	-	3 parts per million
Cyanide as HCN	-	2 parts per million
Phenol or equivalent	-	50 parts per billion
Copper as Cu	-	1 part per million

Cyanide, of course, is important as far as personnel is concerned. A slight acidity can release poisonous hydrogen cyanide gas. Cyanide, copper, chrome, also zinc and nickel are important in the treatment process.

Toxic materials may pass right through the treatment process and have harmful effects on the aquatic life in the receiving stream or on potable water supplies (phenol).

One part per million of cyanide can retard activated sludge, while 2 parts per million may reduce the effluent quality.

There are various opinions about chrome, experimental plants have taken up to 100 parts per million, while others have failed with only a few parts per million. In any case, batch discharges of chrome must be avoided. Most hexavalent chromes come from plating plants. Chrome from tanneries is not toxic.

Copper precipitates in the primary tank and exerts its influence on digestion. A concentration of one part per million at the aeration chamber will reduce nitrification of ammonia to nitrate while 2.9 parts per million may be tolerated by a trickling filter. Less than a half percent Cu by weight in the dry solids will probably have no effect on sludge digestion.

One part per million nickel in activated sludge and 2.7 parts per million may be tolerated in a trickling filter without interference. At 200 parts per million in the wet sludge, some interference in digestion has been noted.

No more than a half part per million zinc is tolerated in activated sludge, 2.7 to 5.0 parts per million in trickling filters. In sludge, up to 1,000 parts per million zinc has been digested.

(i) Noxious or malodorous gases or substances capable of creating a public nuisance, including hydrogen sulphide, carbon disulphide, carbon monoxide, and ammonia.

Many of these gases are part of industrial processes and find their way into waste streams. When the pH in a sewer drops below 7, they are vented to the atmosphere through manholes or at the treatment plant. The odours are offensive or pungent. Operators have been blamed for faulty operation because of odours when these were caused by industrial wastes. The reverse has also been noticed where an industrial waste has been blamed for hydrogen sulphide from a faulty digester or excessive septic sludge in a primary tank.

Hydrogen sulphide is corrosive to concrete and steel equipment. Carbon disulphide, a cleaning solvent for alkali salts, sulphur, phosphorus, iodine, bromine, gums, resins, fats and waxes has been blamed for sewer explosions which have blasted manholes all along many blocks of a street and caused considerable property damage.

Most of these gases, in small quantities are injurious to health and in large quantities fatal.

USE OF PUBLIC STORM SEWERS

Where industrial wastes cannot or should not be discharged to sanitary sewers, discharge to storm sewers or to drains which discharge directly to surface waters should be suitably controlled to prevent pollution. The restrictions placed on industrial wastes discharged to storm sewers are more limiting than for discharge to sanitary sewers, since dilution cannot be depended upon in the sewers and the wastes are discharged to the receiving watercourses without treatment. The following control of wastes to storm sewers is recommended:

"No person shall discharge or cause to be discharged any of the following wastes to a public storm sewer:

(a) Liquid or vapour having a temperature higher than (150°F).

This is, as before, to protect the storm sewer from thermal stress, and, since there is no subsequent treatment to protect aquatic life in the receiving stream from lethal temperature increases and to avoid accompanying reductions in the dissolved oxygen concentration.

(b) Water which may contain more than (10) parts per million of fat, oil, greases or other ether soluble materials or lubricating oils.

This should ensure that storm sewer effluents will not create more than a faint iridescence. Higher concentrations have a tendency to permit oil to separate and cling to shoreline vegetation, coat hulls of water craft, and to generally impair the aesthetic value of the receiving stream.

(c) Gasoline, benzene, naphtha, fuel oil or other inflammable liquid, solid or gas.

This restriction is to protect sewers or to protect buildings connected to the same sewer from damage by explosion or fire.

(d) Garbage or floating objects of any kind.

(e) Ashes, cinders, sand, mud, straw, shaving, metal, glass, rags, feathers, tar, plastics, wood, cellulose, paunch manure or any other solid, viscous, or colloidal substance capable of causing obstruction to the flow in sewers.

The reasons behind this restriction are obvious.

(f) Waters or wastes having pH lower than (5.5) or higher than (9.5) and not remaining within these limits on dilution or having any other property capable of causing damage or hazard to structures, equipment or persons.

Here again the same reasons apply as for sanitary sewers plus the fact that dilution cannot be relied upon.

(g) Waters or wastes discharged from industrial processes containing suspended solids exceeding (15) parts per million or which are capable of passing through a quarter-inch screen.

Since these wastes will not receive further treatment before discharge to the receiving watercourse, the concentration of suspended solids must be as low as that expected in the effluent from a treatment plant. Suspended solids have a tendency to form sludge banks near the point of discharge which may obstruct the flow in the stream, or, if organic, give off odours during decomposition.

(h) Noxious or malodorous gas or substance capable of creating a public nuisance, including hydrogen sulphide and carbon bisulphide.

The same reasons apply here that applied to sanitary sewers.

(i) Waters or wastes in which the biochemical oxygen demand exceeds (20) parts per million.

As in the discussion of suspended solids, above, in the absence of further treatment, the Objectives of Water Quality for the Province should be met. This is to prevent reducing the dissolved oxygen content of the receiving waters unreasonably.

(j) Coloured water or wastes which require a dilution in excess of (4) to (1) to dissipate the colour till it is not determinable by the colour test.

Here again the fact that there may not be any dilution before the waste reaches the receiving stream must be taken into consideration.

(k) Waters or wastes in which the coliform bacteria count exceeds (2,400) Per 100 ml.

This is to prevent a waste with a high bacterial count from rendering a watercourse unfit for recreational purposes or cause unnecessary expense for treatment of the water before re-use for domestic purposes.

(l) Waters or wastes containing the following constituents exceeding the following limits.

Iron as Fe	-	(17)	ppm
Chromium (hexavalent) as Cr	-	(1.0)	ppm
Zinc as Zn	-	(15)	ppm
Copper as Cu	-	(3.0)	ppm
Cadmium as Cd	-	(1.0)	ppm
Cyanides	-	(0.0)	ppm
Phenolic equivalents	-	(20)	ppb
Chlorides as Cl	-	(1,500)	ppm
Sulphates as SO ₄	-	(1,500)	ppm

These suggested limits are to keep toxic metallic ions down to safe levels, and taste-producing chemicals to a minimum, for the protection of aquatic life in the receiving watercourse and the downstream users of the water.

It is suggested that a further clause be inserted to prohibit the discharge of other toxic or poisonous substances about which there is not enough information to allow a definition of limits. Provision should also be made to restrict the discharge of chemicals not yet in common use or not yet on the market but which may prove to have harmful effects if discharged to a watercourse.

Dr. Berry:

Thank you, Mr. Harris, for that very excellent paper. The question of the control of industrial wastes before entering treatment plants is becoming of increasing importance, and I am very glad this paper was presented today. Now, Mr. Caverly, I wonder if you care at this time to make further comments.

Mr. Caverly:

Mr. Chairman, ladies and gentlemen, my comments will be brief. From our experience in operating plants, I must admit that I am rather sensitive to this problem of industrial wastes in domestic sewers. When one is operating a plant, one shouldn't take the attitude of a prima donna, so to speak, but these wastes should not be accepted for treatment. Our OWRC policy has been that we will take all wastes we are physically able to treat, but in the experience of the 30 odd sewage plants which are now running in the province, we have a number of them where treatment is virtually impossible due to the discharge of certain industrial wastes.

Mr. Harris has made reference to pH, and in one of our plants we have these pHs of 12 coming down. We had this situation last week in one of these plants, and the normal bacteria in your biological process is not capable of withstanding a discharge such as this. So, naturally, the process goes off, the plant starts to bulk and you get an inferior quality of effluent. The operator is powerless to do anything about a situation such as this. He has no control over the wastes coming into the plant, and he can alter his process only to the limit of his plant's efficiency. In an activated sludge plant, he does have more control, more things at his disposal to alter his process, such as changing air, putting in condition sludge, but when you get something such as this, it's like trying to stop a railroad train by putting your hand out. It just can't be done. These are problems which we in the Operations Division of the Commission see through different eyes than other people. This is a very serious problem in the efficient treatment of sewage. Thank you.

Dr. Berry:

Would anyone like to carry on with the discussion, or ask some questions?

Dr. Prevost:

I am just seeking advice for Quebec. As you know, we have very few plants and, of course, we are going to have to face these problems of industrial wastes. We think that it is good policy to sometimes to mix those industrial wastes with municipal wastes--with sanitary wastes.

But, until then, if you were in our place and knew you wanted to produce some results, would you, at the start, consider industrial wastes, or go ahead with the municipal sewage and then wait for the future to consider industrial wastes?

Mr. Caverly:

I think the way to approach a problem such as that, and I must say we are doing this here in Ontario now, and that is, make a very thorough industrial waste survey of the municipality before the treatment plant is constructed. In this way, you can, in your design, provide for the taking in of a lot of these industrial wastes, especially the ones with high BODs. In other words, if you increase aeration sections, enlarge those particular parts of the plant, you can overcome a lot of the problems caused by industrial wastes. The thing is, though, to try to take in as much of this industrial waste as you can and still keep up good treatment. There must be some sort of regulation to prevent the discharge, or keep within limits, the discharges of these certain substances which so upset your treatment process.

Dr. Prevost:

We don't know anything about industrial wastes at our stage, so is it better to look half spent at the moment and go ahead with municipal sewage treatment.

Mr. Caverly:

I think you have to look after it at the same time. I don't think you can separate the two. In Ontario, we like to see the two going ahead together. Maybe it wasn't brought out in the paper, but a lot of these industrial wastes can be brought down to the limits by treatment works at the industry before discharge into the sewer, and this is where a good deal of work can be done to eliminate this problem. That is, you can, with pre-treatment, bring these wastes down to a level where you can discharge them into the sanitary sewer or into a storm sewer directly into a watercourse. Mr. Harris in his paper did outline the tolerable limits which we have set in Ontario for these discharges.

You are, I think, asking for a great deal of trouble if you design a plant without giving consideration to these industrial wastes. I am all in favor of taking the industrial wastes in providing they can be treated at the plant, but I know from our own experience, we have had some instances where without surveys of the industries and their wastes, difficulties arose. So, I would say that right at the beginning you should make certain that the wastes which are being discharged by industry can be treated at the plant.

Dr. Prevost:

It would be simpler treatment.

Mr. Caverly:

I wasn't thinking so much of simpler treatment resulting from the survey plan. However, you may conclude you don't want to take industrial wastes to the municipal plant at all.

Dr. Prevost:

Well, suppose we don't make the survey, and suppose we want to rush our plans for treatment of municipal sewage alone?

Mr. Caverly:

If you want to rush, of course, I think the thing to do is to take all wastes into the sewer, but you may run into a lot of difficulties.

Mr. W. L. Rice, P.Eng., Chief of Civil Engineering, Department of Public Works, Toronto;

I would like to disagree in a kindly and friendly way with remarks made by Mr. Eric Baker, that you can't build and operate dams to store water for multi-use purposes. The Ontario Department of Public Works builds about 10 dams each year for the Department of Lands and Forests, which operates them for more than one purpose. Our department builds, maintains and operates a chain of dams in the Muskoka Lakes, and their headwaters. In order to satisfy the many users of the waters, they have to be operated to suit seven different interests--

1. Recreation, including boating, bathing and swimming during the summer.
2. Fishing, principally in the spring and fall.
3. Protection and propagation of fish and wild life.
4. Domestic water consumption.
5. Landing areas for aircraft used for fire fighting.
6. Hydro electric power development.
7. Flood control for protection of property.

If this is impossible to do, you have heard that with engineers it only takes a little longer. If you want to know how it is done, you are invited to visit our office in the Parliament Buildings.

Mr. Baker:

One can never resist an opportunity like that. I agree fully that you can have a number of different things put together, but you can't have a full scale flood control and full scale recreation. You have to settle for a compromise where many of these things are concerned.

Mr. Snider:

The next paper is "Research in Water Quality" by Mr. Don Redfern, Consulting Engineer, Toronto.



RESEARCH IN WATER QUALITY

D. B. Redfern, B.A. Sc.

Proctor & Redfern, Consulting Engineers



Any paper with such a title must of necessity be general in nature. What I will attempt to do is to assess the present status of research programmes in the Province in this field, the need for research in the future, and to suggest what general types of research programmes could be performed by (i) government and (ii) industry, both from the point of view of a Consulting Engineer.

Before dealing with this, however, it becomes necessary to define the different types of research that can and must be performed in our complex society.

First, of course, is basic research; that branch of research devoted to original work attempting to find out more about nature and her laws. This is the field of the scientist as opposed to the engineer.

Second is what one could call applied research; that is the practical application of basic knowledge in the furtherance of practical benefits to society at large. A part of this phase of research is at times almost basic research.

Third is that phase of research dealing primarily with the collection and dissemination of information. This phase is of equal importance with the other phases, as with intelligent use it circumvents duplication of effort and provides management with needed averages, trends and costs for comparison or other uses.

PRESENT STATUS

At the present time in Ontario research in all phases of this field has been spotty. This is perhaps understandable in that public awareness of the problems of and need for water quality control has only recently reached the stage of a call for action against unnecessary pollution of our waterways. It is only in the last five to ten years that the tremendous expansion in our Province has created concentrations of population and industry that have taxed the water resources in certain sections of southern Ontario. This expansion has not only taxed our water resources from the quantitative standpoint but also from the qualitative. This is not to say that progress in water quality control has stood still in the last five to ten years. Far from it. There have been greater advances in the Province during this period than at any other time.

Prior to 1950 the number of municipal sewage treatment plants in the Province was few with most only giving primary treatment. Some plants had been built

immediately following the war and there were a number of older plants in operation most of which were built between 1926 and 1932. In effect, in 1950 we were just beginning to crawl in our overall development in this field. By the year 1960, over 4,000,000 persons in the Province were served with municipal sewage treatment plants; that is about two-thirds of the total population. In the same period of time, not as much has been accomplished in the industrial waste treatment field. Many industries, particularly in the larger centres have their wastes treated in combination with domestic sewage, with or without pre-treatment. New industries latterly, have proceeded with their own waste treatment works, either as the ultimate means of treatment or as a pre-treatment of waste before combining with domestic waste for further treatment. There still is a major problem with industrial wastes, from those industries producing enormous quantities of waste where it would be totally uneconomical to treat all the waste to produce an effluent of municipal standards and also with industrial wastes from smaller industries in smaller centres where the relative waste volumes are such that combined industrial and domestic waste treatment is impractical, and where there are serious physical and economic limitations to the industry providing treatment facilities of its own.

The Ontario Government has provided through the Department of Health and more recently through the Water Resources Commission valuable assistance in the third category of research particularly in the collecting, testing and reporting on water quality. This service of course, is partly regulative and necessary in the day to day operation of waterworks and sewage facilities. More recently the Water Resources Commission has embarked on a more comprehensive compilation of information with the publishing of its first few of many County and District Surveys of Surface Waters.

Industry's contribution to research in water quality control has been two-fold. First, those industries in the water quality control field have contributed a considerable amount in their quest for more reliable and saleable products. This applied research programme has been directed, naturally, with particular industries towards the improvement of their own existing equipment styles and processes.

Much of the industry in this field in Canada is a subsidiary of a large foreign parent company and to this extent not all of the equipment and process improvements have the best application here.

Second, several industries in Ontario in locating new plants have been leaders in the provision of adequate treatment facilities for their own wastes. To a certain extent they have been forced to provide treatment facilities, however, in certain instances it has not been a matter of the industry providing as little treatment capacity as possible but there has been a true feeling on their part of wanting to provide all that is necessary in the treatment of their waste to ensure that as little pollution as possible will enter the receiving waters. This, unfortunately, has not always been the case. However one cannot blame certain industries too much for their negative attitude towards waste treatment and water quality control, where such treatment could have such a marked effect on product price as to jeopardize their competitive position.

My remarks to date have been and will continue to be directed towards pollution control as opposed to water treatment. I feel that of the two pollution control needs more attention. It is only by the control of certain wastes that we can use water for potable purposes at all. As long as a reasonable standard of pollution control is maintained in our waters the further treatment for industrial or potable water supply is reasonably straight forward.

WHAT ARE THE NEEDS

The needs for research in this field are many and varied.

Engineering and Contract Record reports that of some 3.0 Billion Dollars to be spent this year in Engineering Construction in Canada, some 250 Million Dollars will be spent in the sanitary engineering field. This has increased from some 200 Million Dollars in 1957. The amount to be spent in the future will certainly increase with (i) our continuing population increase (ii) a backlog of work to be done particularly in the smaller communities in Ontario and in the industrial waste field (iii) the increasing amount to be spent in repair and replacement which is evident today in sewers proper and will become more apparent in sewage treatment works within the next ten years.

The Ontario Water Resources Commission reports that for the last two years (1959 and 1960) and with the trend continuing for the first nine months of this year, it has approved of applications for construction of approximately 120 Million Dollars annually in the sanitary engineering field.

For the years 1960 and 1961 this has been divided into sewerage applications, 72.5%, and waterworks applications, 27.5%. No breakdown is available on sewerage applications as between the pollution abatement phase (provision of treatment plants, outfalls, trunk collector and interceptor sewers) as opposed to the small local improvement sewer, however, I would expect that well over half would fall into the former category.

This statistical information is given to show the dollar amount spent in the field and the increasing trend of such expenditure. This I feel points out two important items as related to research (i) the fact that more money is being spent shows the public awareness of an increasing problem and (ii) with the dollar volume involved the need to make sure that the money is spent in an intelligent and economical fashion.

The above illustrates the need in a quantitative sense. Much more important is the need in a qualitative sense.

The sanitary engineer deals with physical and biological stresses, and, in its broadest sense, with the social stresses of the environment and their impact upon man. The sanitary engineer working jointly with biologists, physicians, statisticians, and epidemiologists, has largely conquered the communicable disease which are spread from the source of infection to man through his environment.

.. Today, in Ontario, therefore the need for research is not toward the filth born disease and its control but to the control of pollution from all sources to give the public a clean and decent environment. The need is two-fold -

(i) to improve our processes and techniques used in controlling known existing pollution and to find the technical means of controlling pollution from new processes as yet unknown and

(ii) to determine to what extent the broader problem of pollution tolerance in our waters (recognizing that increased expansion means increased pollution regardless of treatment while the flow of water remains constant) can dictate our economic and sociological development.

WHAT IS NEEDED

The first requirement for any research programme is a clear objective of what is needed. All too frequently monies for research programmes are limited and it is essential, therefore, that the programmes be selected carefully to get one's money's worth. This is not to say, of course, that you can sit back with a crystal ball and select only those programmes which are bound to succeed. Much research in itself comes to a dead end with no visible return from the money expended. However, it is possible with careful planning to direct the programme to known problems of the time and those which can be reasonably foreseen in the future.

The Twenty-Seventh Research Report of the Committee on Sanitary Engineering Research of the Sanitary Engineering Division of the American Society of Civil Engineers published in 1960 stated: "Many of the specific research needs now recognized can be grouped into broad problem areas: (1) Reclamation and reutilization of waste waters; (2) ecology of receiving waters; (3) integration and co-ordination of water pollution control with water resources management; and (4) development of more and better research personnel."

In Ontario we are in general faced with the same problems with the possible exception of (1) above. We are fortunate in this Province with our abundance of water; our development to date has not taxed our total water available whereby the reclamation and reutilization of waste waters is a necessity. This is, of course, not so in all parts of Canada. Industry in the Prairie Provinces has been practicing the reuse of waste water for years.

Second is the grouping of specific projects required to overcome difficulties and unknowns in the efficiency of existing and proposed treatment units. From my knowledge of problems in this area, I would say the most important areas requiring further work are: (i) Sludge digestion; (ii) undigested sludge dewatering and disposal; (iii) synthetic detergents; (iv) toxicity in biological treatment processes.

The first two items above do not necessarily contribute directly to pollution in our waters although improper digestion and the return of highly concentrated supernatant to the liquid treatment process can have a marked effect on overall treatment efficiency. With these two phases of treatment we are mainly concerned with odour problems, and with subsequent problems of possible contamination of land depending upon the ultimate means of disposal of sludge.

The synthetic detergent problem is one that is receiving a great deal of attention in the United States. This field is probably not one that we would get too deeply involved in as our friends to the south have a problem that is much more acute and consequently will spend much time and money investigating the possible reduction of non-oxidizable components of the synthetic detergents.

The problem of toxicity in biological treatment processes is, of course, extremely important as it is only with a healthy sludge that we can remove as much of the impurities in our waste streams as we do.

Third is the longer range research programme particularly directed to the ultimate use of our total water facilities in the Province. Much work in this field of endeavour has been done by the International Joint Commission on Boundary Waters between the United States and Canada.

I feel that the time has come in this Province that similar work should be initiated on our inland lakes and waterways, particularly in the southern regions of the Province where the water quality problem is more acute.

Many people from many walks of life and with many points of view as to the use of water have to be consulted in such a programme. There are problems as to the disposition of water for Hydro Electric, potable water supply, irrigation, flood control and conservation, and recreational uses. Attendant with this is the need to limit total pollution from all sources to ensure that the water in any particular watershed is of a quality to allow for the various uses that might be permitted.

This, of course, is an enormous problem as its ultimate solution could mean the actual direction of where and what type of growth is to be allowed in the Province. This could mean the uprooting and movement of existing population and industry with its attendant economic and sociological problems. Such a programme could also have a marked effect on land values. Realizing all this, it is evident that this is not so much a problem in water quality control as a problem of our political, social and economic values.

However, I feel that some preliminary work in this field should be done. We should start to determine in one, or possibly two, test areas what ultimate use can be made of an inland river. From this, work could be done

in more detail on the possibility of various types of stream and river classification with possibly a sliding scale of pollution load tolerance from municipalities, industries, and other producers of wastes. I realize that many people would be opposed to the theory of stream classification: that it could restrict development needlessly: that it could put artificially low and high values on land: that it could force industry to locate in a disadvantageous position with regard to labour market, distribution costs etc. I agree that these are very serious problems but not insurmountable ones.

I am not recommending that stream classification be started forthwith, but rather that a study be made in sufficient detail of one of our inland rivers to bring into better focus what the problems might be in the future, with and without stream classification and the lack or otherwise of total pollution load control.

Running over rather quickly our Ontario rivers, I do not think we could pick a better one to study than the Grand. Here we have a River system draining a highly productive farm area interspersed with highly industrialized conurbations. We have the River used as a disposal point for liquid wastes from municipalities and industries both treated and untreated. We have conservation works built and more planned. We have municipalities and industries using water from the River and from underground supplies for both potable and process purposes. We also have available, not today, but in the foreseeable future when increased water consumption demands it, a relatively economical source of additional water supply from the Great Lakes proper.

Potentially we have, therefore, a further study of the relative economics of allowing more and more development with its attendant wastes, maintaining minimum dilution volumes constructing storage facilities and/or supplementing with Great Lakes water.

In any research project of this nature close liaison would have to be maintained with other interested bodies such as planning authorities, conservation groups etc. Possibly the benefit from such a study could be of great value in these other fields. In the planning field, for instance, new authority might be created in a regional type planning jurisdiction, the limits of which might be on watershed or combination of watersheds boundaries.

Facing facts, there are many regions and even countries in the world where the very existence of the economy is tied so closely with quantity of water that this is the guiding and limiting force of development. We in Ontario have been to date, wasteful with our water resources due to the abundance of the same. Our problem in the future will be, I feel, more in the qualitative than quantitative control of our waters.

If other parts of the world can exist under stringent water restrictions, surely we, by careful planning of water uses and quality control, can provide a tremendous future for our progeny in a properly balanced industrially productive and sociologically balanced environment.

WHO CAN DO THIS RESEARCH

I think it is obvious from the discussion of what research should be done that it is necessary in any research programme that there be the closest co-operation possible between all interested parties.

Industry can assist greatly in such a programme, both from the point of view of the continuing development of better products to be utilized in this field and also by the continued development of a co-operative attitude toward the solution of their own waste problems. To this and the problems facing the individual industry can be overcome to a great extent by the formation of loose or formal associations with other firms in a similar line of endeavour or with similar waste problems. This could allow for the spreading of research costs between several firms and would also ensure that as little money and effort as possible is wasted by a lack of proper distribution of information. Industry should continue to lead in the research into specific detailed problems to produce the workable solution with economic processes and equipment.

The other phases of research which should be embarked upon should be fulfilled more by Government including, for instance, the suggested long range programme for the Grand River. In addition, Government can and should continue to act as the collection and distribution centre for statistical information to enable persons interested in the field to plot trends so corrective and/or planning procedures can be instituted at the proper time. I would like to stress the distribution aspect again as many so-called new problems have already been solved many times before and certain problems are only problems due to the lack of information in the area where the problem occurs.

Much work should be done in the standardization of methods of reporting before information can be used for comparison purposes with any degree of certainty. This again points to the use of Government as the central clearing house where standard methods can be employed.

My final thought is that to carry out a more intensified research programme we must have the qualified staff to do the same. I suggest, therefore, that more emphasis should be placed on this field in our universities in the Province both at the undergraduate and post-graduate levels.

Mr. Snider:

Are there any questions you would like to ask Mr. Redfern?

Prof. Keith L. Murphy, McMaster University, Hamilton;

Mr. Redfern covered just about all the points I was scheduled to bring up a bit later in the afternoon. In particular, I want to support the distribution aspect of the research information available. A tremendous amount of information obtained in research projects in the United States at the various universities is not made available generally, and it is not surprising for someone finishing a three or four-year program on research to find that a similar program had been carried out in other parts of the country. This is not at all uncommon, and it is also very frustrating to the individuals concerned. Here is a classic example of misuse of research funds.

I would disagree somewhat with the statement that pollution is the major aspect to be studied. Certainly this is partly true, because our conventional water treatment methods are not able to counteract virus infections or other infections or other epidemic diseases of this type. We have the bacterial diseases in hand with our present treatment methods, but a great deal remains to be done in this other field, and I think that with reuse of water this is going to become increasingly important.

The point that we in this area are not as concerned with reuse as we should be is well taken, and possibly for this reason it is the pollution aspect which should be considered.

Mr. Snider:

Unless there are further questions in connection with Mr. Redfern's paper, we would like to proceed with the water quality problems and combine to an extent with the water storage guided discussion which was not completed this morning. I am going to ask Dr. Berry to preside again.

Dr. Berry:

We have a large number of questions to discuss here and, as I pointed out previously, this is the means we adopted in order to get this information.

We cleared up "The Water Resources Needs of Ontario" earlier. The next one we go down to, for which there are questions, is "Water Storage". A number of persons have been asked to speak on this, but that doesn't mean discussion is limited in any way. We want the discussions from the floor at all times. The first concerns "To what extent can water storage facilities be used to improve stream sanitation?"

We have been getting some information on that, how much storage do we need in order to take care of flows in the low flow season. The first person I have on this is Mr. Boardman of Toronto.

Mr. H. E. Archibald, R. K. Kilborn and Associates, Consulting Engineers,
Toronto;

Mr. Boardman is not able to attend the conference today, and he has asked me to do so for him. This question is, of course, closely related to the other questions that follow in the discussion on Water Storage, particularly question d. - "What are the likely effects of storage on water quality and how will this influence downstream conditions?"

This latter question has been assigned to Mr. W. A. Scott of our firm for discussion. We have worked together in preparing our answers to these two questions, and have chosen to deal with separate aspects of them.

Water storage facilities in the context used here may be either natural reservoirs, such as are formed by lakes, or may be artificial, such as are created behind dams which have been constructed for any number of purposes.

A stream, upon reaching a reservoir, will have its velocity reduced. This will result in the stream unburdening itself, to a greater or lesser extent depending upon the conditions, of its load of silt and other settleable materials. This, in turn, will have the effect of reducing the turbidity, the color and some of the bacteriological load in the waters of the stream. While the removal of this settleable material may be of benefit to the water users downstream from the reservoir, the continued accumulation of silt could cause future problems to the authority operating a dam because of the loss of storage volume in the reservoir and the eventual need for silt removal. Fortunately, this is not as serious a problem in Ontario as it is in some other parts of the world.

A somewhat parallel comment might also be made here in passing. During the discussion on some of the papers yesterday, a natural concern was expressed about the effect of radioactive fallout on water supplies. It might be noted that this fallout is largely particulate matter which will settle out in quiescent water. A case might be made for the use of multiport water intakes placed in a storage reservoir, so that water could be drawn off at the least-contaminated level. Although the adoption of such a procedure is unlikely to produce a perfectly "fallout-free" water, it would reduce the load on any treatment works, such as coagulation and diatomite filtration, that was designed to treat such waters.

On streams where wastes are added to the waters in varying concentrations or amounts, a downstream reservoir has the effect of further diluting these wastes and passing them on at a concentration more closely approximating the average. This will benefit downstream water users to the extent that their water treatment facilities will not have to be continually adjusted to meet wide fluctuations in the quality of the raw water.

I will leave it to our Mr. Scott to comment further in regard to this question.

Mr. W. A. Scott, R. K. Kilborn & Associates, Consulting Engineers,
Toronto;

Thank you Mr. Archibald. This is indeed a broad subject and one worthy of being a topic for a future conference. Consequently, these few brief remarks are of a general nature only, as the effect of storage on water quality and stream conditions downstream should be assessed independently for each storage site knowing the hydraulic and hydrologic factors of the watershed, condition of the existing stream, reservoir characteristics, pollution load, etc.

Mr. Archibald in section (a) of this discussion has defined storage and has outlined the effects of water storage to improve stream sanitation by

- (a) decreasing turbidity.
- (b) improving bacterial quality.
- (c) dilution of local concentrations of industrial and domestic wastes.
- (d) providing a settling basin for radioactive wastes.

Water storage has a further benefit on conditions downstream through a decrease in water temperature which is of benefit to both fish life and domestic users. Of course, as the distance downstream from the reservoir increases, the temperature of waters released from storage will approach that of the natural stream.

Reservoir storage may also be used to increase the low flows that would occur if no storage was available. The major dams on the Grand River watershed are presently used for this purpose, and, in the eyes of many, the use of storage to augment the base flow is as important a feature as flood control.

In the case of the Grand River, the lowest average monthly flow for the period of record without storage is 47 c.f.s. With the development of all of the proposed reservoirs, sufficient storage will be available to ensure a base flow more than eight times greater.

On the other hand, water storage may also have a detrimental effect on downstream conditions. The dissolved oxygen in the water may decrease through the elimination of natural channel aeration and long impoundment with a deleterious effect to fish life and municipal water supply.

The problem of algae formation, which was the subject of Mr. Neil's paper in yesterday's session, may be increased with possible major effects on downstream conditions including changes in the physical and chemical character of the water. These changes may create taste, odor and color problems, and complicate and interfere with domestic water treatment and may infect distribution systems. One consolation is that algae does assist in the self-purification of polluted streams and is an essential part of the food cycle for fish life. If algae growth can be effectively controlled, water quality should be improved, but the full effect can only be assessed by a detail study of all the facts peculiar to a particular storage site.

Dr. Berry:

Thank you Mr. Scott. Would someone else like to discuss that first question under "Water Storage"? If not, we will go on to the second one, "What amount of storage is desirable to augment low stream flows which must receive treatment effluents". The augmentation of these low flows which must receive waste effluents. The first one I have on the list for this is Mr. W. R. Edmonds of Ottawa.

Mr. W. R. Edmonds, P.Eng., Assistant Chief, Public Health Engineering Div., Department of National Health & Welfare, Environmental Health Centre, Ottawa;

To answer this question, Mr. Chairman, it is assumed that some basic data has been accumulated or collected relevant to river flows, the amount of domestic sewage and industrial waste contributed to a particular stream and the approximate B.O.D. loading involved. For economical reasons storage requirements in such instances should be determined on the basis that will satisfy stream loading conditions arising from the discharge of treated effluents from domestic and industrial sources. In this way only, can we achieve the fullest advantage possible of the value of storage reservoir development for stream sanitation purposes in the attainment of water quality objectives during critical stream flow periods.

Several purposes would be served through the development of impounding basins or reservoirs as an adjunct to pollution control during periods of low stream flows. These are:

- (1) To maintain levels of oxygen and pH adequate to preserve aquatic life.

- (2) To prevent the occurrence of septic conditions from waste discharges and to minimize the effect of accidental slug discharges.
- (3) To provide the initial dilution necessary for industrial contaminants such as phenolic waste, oils, iron and other oxygen depleting substances in order to achieve those standards of stream quality as set forth in the "Water Quality Objectives", of the Ontario Water Resources Commission.
- (4) To reduce odor producing substances, color and turbidity to a point that will be acceptable, or unoffensive in appearance.

The amount of storage required might be calculated on the basis of the difference in dissolved oxygen saturation levels required to maintain 100% oxygen saturation at 20°C. Some authorities suggest the amount of storage required using this approach could be as much as 4 c.f.s. per thousand population, and that a normal stream might require 2.5 c.f.s. per thousand population.

The point that should be emphasized is that water storage development should not be used for purposes of dilution per se as a substitute for treatment but rather as an additional safety factor in the control of pollution during the periods of low flows.

Dr. Berry:

Thank you Mr. Edmonds. Next is Mr. C.H.A. Killoran, Executive Engineer, H.G. Acres & Company, Toronto.

Mr. Killoran:

The amount of storage required on a stream can only be determined by a detailed study of the characteristics of the effluent and the stream into which it will be discharged.

If the BOD demand of the effluent, its volume and any seasonal variations are known, the load demand on the stream can be determined. Suitable tests should be made to determine the dissolved oxygen content of the stream, its coliform count, and its velocity. The latter is required so as to determine the elapsed time from the entrance of the pollutant into the stream, to the point at which pollution would be objectionable. The flow required for pollution abatement so far as oxidation and dilution are concerned can then be determined from the requirements as set down in the "Objectives for Water Quality in the Province of Ontario" as adopted by the Ontario Water Resources Commission.

The next step should be the examination of the flow records of the stream to determine its discharge during the most critical drought period. If the lowest flow in the stream is insufficient to meet the OWRC requirements, the deficiency must be made up by drawing from storage.

The minimum volume of storage required can be found by first tabulating the difference between the actual and required flow for each day of the critical flow period. The sum of these differences represents the total number of c.f.s.-days that are deficient, and from the relationship that one c.f.s.-day is equal to two acre-feet, the volume of storage can be determined. To this volume should be added allowances for evaporation, infiltration, seepage and the reduction in reservoir volume due to silting.

The use of a storage dam and reservoir to augment low stream flows should be considered only when the construction and operating costs of the dam are substantially below the cost of installing equipment for additional treatment of the effluent before it enters the stream, and when there is no infringement on the prior rights of other riparian owners.

Dr. Berry:

Are there some thoughts in connection with that question? Would someone else like to comment on it? No, then the second question is "The amount of storage desirable". We see a good deal in the literature and in our contacts with the United States people concerning the emphasis which is being put on storage on these major streams. There appears to be a consensus that they are justified in spending a great deal of money on reservoirs in order to maintain good sanitary conditions in the stream, to carry away the treated effluents during the low flow periods. It certainly is very helpful when one does have a good deal of water to mix with the effluent, even if that effluent is highly treated. Any other comments on that? We will next go on to, "What is the economic relationship between water storage and stream sanitation."

Mr. S. G. Barber, P.Eng., Chief Municipal Engineer, Marshall, Macklin & Monaghan Limited, Don Mills, was asked to reply, but he had to leave. However, he left some information for me which I shall read.

"The economical relationship between water storage and stream sanitation is difficult to determine because of the factors involved.

"We can approach the question from the viewpoint that the cost involved to impound a given amount of water must produce economic benefit equal to or greater than the investment in water storage facilities.

"The benefit which may be derived from increased stream flow because of water storage is improved stream sanitation. In addition, there are secondary benefits resulting from the water storage impoundment such as, flood and erosion control, fish and wildlife conservation, recreational facilities, and, perhaps, capital appreciation of adjacent real estate.

"The benefit most pertinent to the question under discussion is improved stream sanitation and since waste disposal constitutes one of the legitimate uses of a stream within certain limitations, then the natural self-purification capacity of a stream is an economic asset.

"We can gain an economic benefit if, by the use of water storage, we can maintain or improve the self-purification capacity of a stream.

"The cost to provide water storage is a tangible thing and can be determined with reasonable accuracy, however, economic benefit derived therefrom is intangible and cannot be determined with the same degree of accuracy.

"In conclusion therefore, I am of the opinion that the answer to this particular question cannot be given in general terms for each and every application but must be determined by comprehensive study of individual problem areas."

Dr. Berry:

He doesn't put it in dollars and cents, but I presume it would be very difficult for anyone to do that. However, he is taking full benefit there for an increasing flow insofar as waste treatment is concerned. Would someone else care to make any comments on that third question?

In a reply to a question concerning the possibility of radioactive fallout affecting public water supplies, particularly in regard to Strontium 90, Mr. Kim Shikaze, OWRC Purification Processes Branch, replied:

Mr. Shikaze:

My personal opinion is that at the present time the quantities are small and, as I mentioned before, it is the maximum permissible concentration we have to take into consideration as well as the level of Strontium 90 in milk. I don't doubt that Strontium 90 is present in milk and the water supply, but I don't think the levels are anything to worry about yet.

Dr. Berry:

Thank you. The next question is "What are the likely effects of storage on water quality and how will this influence downstream conditions". Two aspects to that--what is going to be the change in the water in the storage, and how is that going to affect it downstream? Mr. Galimbert is the first one on this.

Mr. G. M. Galimbert, Assistant General Manager, OWRC;

Water quality can be affected by impoundment so as to influence downstream conditions. Unfortunately one cannot report universal improvement due to the establishment of storage reservoirs as there can be detrimental effects to impoundment in addition to beneficial effects.

It is best to indicate first the beneficial effects that occur from the establishment of a storage reservoir on a stream. These include the reduction in coliform bacteria and the resultant improvement in bacteriological quality of the water over a period of time, the reduction of turbidity due to the long sedimentation period, the lowering of the temperature of the water that may sometimes benefit fish life, an evening out of various chemical constituents and the provision of a supply of water for release at dry periods for the dilution of sewage and other waste discharges.

The major advantage from a water quality standpoint is the reduction in the coliform bacteria and the evening out of the chemical constituents of the water. This assures to some extent a better quality water for fish life as there will be less variation in dissolved minerals, hardness and pH. The reduction in bacteriological contamination would be an assistance to any water works located below the impounded area. It would help in the provision of better quality water in bathing areas on the stream in an effort to obtain the tolerance permitted in such areas of 2400 total coliform per 100 ccs.

One of the major benefits of impounded water is that it provides dilution for sanitary and industrial wastes during critical times of the year. This is of particular advantage in streams where the dilution requirements per 1000 persons are not up to the requirements of 2.0 to 4.0 cu. ft. per second for primary effluents and 0.3 to 0.5 cu. ft. per second for secondary effluents. This dilution should however, not be used as a substitute or a reduction of the waste treatment provided. There is no doubt that the provision of storage water on small streams can be of definite benefit where the dilution water is of a marginal amount from a quality standpoint.

Impoundment of water has certain undesirable effects on the receiving stream below established reservoir. These include increased growth of algae, which may give rise to tastes and odours. (2) Reduction in dissolved oxygen; and on occasion increases in dissolved solids and hardness as a result of evaporation in the reservoir.

The most important of the undesirable effects is the increased growth in algae that may cause the development of objectionable tastes and odours at water supplies below the reservoirs. An outstanding example of this condition in Ontario is Brantford where difficulty from an

odour and taste standpoint is worse since the creation of the dams on the Grand River even though more dilution water is now available. Algae has to a major extent been responsible, although industrial wastes have been a factor, to the extra treatment required of super-chlorination, aeration, carbon application and de-chlorination in addition to the chloramine treatment that was provided before the establishment of the dams.

There is an increasing need for more thorough studies of stream impoundment and its effect on water quality on receiving stream water below. These studies may point the way to solve some of the technical problems that exist at the present time and may assure better quality water. On the other hand it must be remembered that the provision of better water quality is only one of the intended purposes in the establishment of impoundment areas.

Dr. Berry:

Thank you. The only thing you left out was fluoridation. Any other comment? Is Mr. Norman of the Dillon Company here? He is listed for comment here.

Mr. J. D. Norman, M. M. Dillon & Company Limited, Consulting Engineers, London;

Storage reservoirs also, as we are all aware, reduce the flood peak. Reduction of the flood peak, of course, decreases silting problems downstream, decreases erosion problems downstream, which without the reduction of flood peak could be a serious factor. I don't suppose we want to get involved here in the silting of the reservoir, do we, or do we?

Dr. Berry:

Anybody want to comment on that? While you are up, Mr. Scott, tell us about that.

Mr. W. A. Scott, R. K. Kilborn & Associates, Consulting Engineers, Toronto;

One further comment, sir--the question of the silting of a reservoir, as we all appreciate, has not reached the stage in which sufficient research information is available. I think a number of years ago the Upper Thames Valley Conservation Authority made a preliminary survey of Fanshawe Lake after four years of operation. At that time, I think, the results were that the storage capacity was reduced approximately 0.5% of the permanent lake level, or less than 0.1% of the cold storage volume.

Dr. Berry:

Someone else care to comment on this? All right, Dr. Prevost.

Dr. Prevost:

If impoundment is in the upper watershed with relatively pure water, I would say that it could be beneficial. However, if it is in the lower part where you have a lot of sewage, even treated sewage, and treated water, benefits would be doubtful.

Mr. Scott:

Firstly, I don't think that reservoirs themselves create the silt problem. The silt problem is there. If it is not deposited in the reservoir it is going to be deposited elsewhere downstream, with probably later problems arising elsewhere. Secondly, I suggest that by the construction of reservoirs you do decrease the velocity in the stream. You do not only decrease the velocity upstream in the reservoir, but you also decrease the volume of flow downstream from the reservoir. Consequently, I would suggest that the volume of silt should be that much less.

Mr. J. D. Hisey, Hisey & Barrington, Consulting Engineers, Richmond Hill;

It seems to me this business of building large storage dams is self-defeating because we start at the tail end of the problem and try to work back the other way. Actually it would appear the proper place to begin with the silt problem is on the upper part of the watershed, at the farms where you still have people that are plowing up and down the hills. If you drive around the country today, you will see plenty of places where the silt problem is being created, in the Grand Valley, for instance, by property that is improperly managed on the farm, and no amount of cleaning of dams and storage of water is going to solve that problem. It begins farther back.

We have had experience with quite a number of these, and I know some of them, in the period of relatively a small number of years, are today practically useless. They were built as irrigation storage water reservoirs, and many of them today are written off and are used as pasture fields today. We have to begin much farther back at land-use management and begin thinking of water purification at the start.

Mr. G. H. Richards, P.Eng., City Engineer, Brantford;

I was greatly interested in the remarks of Mr. Galimbert, and I heard the same criticism from the analyst or chemist down at the Public Utilities Commission. Every time I brag about the good job we have done on the Grand River Conservation Commission, exception is taken to it, and apparently it is not all beneficial. However, there are one or two features

which I think should be brought out. In fact, one speaker did say that these dams are double-barreled in their benefit. As far as Brantford is concerned, the dam in question was built primarily for flood protection. We have three dams on the river, and in my opinion they have done a tremendous job as far as flood control is concerned. However, we must also remember that of the 2,000 square miles above Brantford, only 600 square miles are above the dam--in other words there would be 1,200 square miles with absolutely no control whatsoever. Those dams were in operation during hurricane Hazel. The valley of the Grand received only slightly less than half the rainfall that fell in the Humber, but we still were in a very critical condition. The flood waters lapped within feet of the top of the earth dikes, and as you know 1-1/2 or two feet of freeboard on an earth dike puts an engineer in rather an uncomfortable position.

The other feature which has not been mentioned yet, and that is strictly from the municipal viewpoint, finance. There is a lot of difference in the way these things are financed. On a water treatment plant, there is 100% charge on our people, and up until just a year ago sewage treatment plants were a 100% charge against our people. We are very happy that the Federal Government has decided it should help out a little bit. While the Brantford plant was built just a little too quickly to take advantage of this help, it is very nice that, from now on, we can expect a 16-2/3% subsidy on sewage treatment plants. Dams, if I remember correctly, are subsidized to the extent of 75%. Now, to an alderman or a financial man, or a man who is worried about the city budget, that represents a substantial difference in subsidy. A dam up there would cost about \$2-million, \$1-1/2 million by the senior government, with the other half million spread among the municipalities.

I think we could build another one, but I am very much afraid some people seem to think that because we built those three dams we are safe. Believe me, we are not safe, and I think we are going to have to build for flood protection. I hope, Mr. Galimbert, that it doesn't do any harm to our Public Utilities Commission. I doubt whether it will. In fact, I can recall one incident when it was a very definite benefit. There was some phenol dumped into one of the tributaries of the county sewer, and they were mighty glad to have water from the dam to wash it downstream.

Mr. Galimbert:

I would like to say I recognize the advantages referred to, but I was asked to speak on water quality and I would look at the expenditure last year of \$500,000. by the City of Brantford which might have been avoided if they didn't have those dams up the river.

Dr. Berry:

Thank you. Now we are both in agreement. Let's go on the section E, "What would be a desirable program for water storage in Ontario's streams".

Mr. N. L. Johnson, Secretary-Treasurer, Upper Thames River
Conservation Authority, London;

A desirable program would be that it meets the needs of the people on the watershed, provides maximum utilization of the water available. It is felt that the water storage system with its multiple purpose reservoirs provides flood control, summer flow, water supplies, and water for recreation. It is felt that the reservoir system should be expanded to provide a greater volume of summer flow to improve the quality and appearance of streams and rivers. I will give, as an example, the Upper Thames. It's been mentioned before, so I am not just bringing this up for the first time. The flow in the Thames River gets as low as 35 cubic feet per second. Ten years from now, when we have our dams built--we have one now and we propose building five others at the end of that time-- we can guarantee 350 cubic feet per second, or 10 times the minimum flow for 112 days. Now, of course, these six dams only store a small portion of the runoff that we get each year. I did some quick calculations, and I figure at the end of the 10-year period we will only be storing one-tenth of the runoff, so we could go a lot further. I think, though, to find enough storage space to store all the runoff, we wouldn't have any farm land left. So I don't think that we could go that far. I would just like to back up what Mr. Scott said about siltation. We have only one figure in the curve, but next year we plan to take some more measurements but as you can see, at the present rate this storage will be available a long time before we get silting difficulties.

Dr. Berry:

Thank you Mr. Johnson. Would someone else like to talk on that question?

Mr. J.A.S. Milne, Hydrologist, Ontario Hydro Electric Power Commission,
Toronto;

I would like to go back a bit to explain just what our function is, but please bear in mind I will come to the storage point. We were formed in 1906, probably before many of us here were born, and our primary concern was to develop low cost power. During the time since 1906, I think Ontario has been recognized to change from a primarily agricultural province to a highly industrialized one. In fact, you might attribute the formation of the Ontario Water Resources Commission, in part at least, on the Hydro Electric Power Commission of Ontario, because we played such a large part in bringing this about. As far as storage is concerned, the amount of water we use is fantastic as compared to what we use for purposes of pollution control. As a matter of fact, we figured roughly from the figures which Mr. Symons presented yesterday, we are probably using 3-1/3 million gallons of water per second through our plants. Mr. Walkinshaw, this morning, referred to a lake in northwestern Ontario, and his problem was

one of conservation when he contended recreation on that lake was suffering by virtue of low lake levels. That lake is actually controlled, not by Ontario Hydro, but by a board called the Lake of the Woods Control Board, which comprises one representative from Manitoba, two from Ontario, and one from the Government of Canada. They are the people who are responsible for maintaining at all times a minimum flow in the river, both the English and the Winnipeg.

In 1959, the lake level was down to around 1,166 feet. This figure is not particularly significant but it did mean that we had a very poor winter. Surveys taken by ourselves and other agencies indicated a very low percentage of water content for that year so that withdrawal from the lake was limited in the early spring. Unfortunately, in June and through July and August, we had very extensive and heavy storms to the point that the lake rose to 1,172, which is maximum level, and during an attempt to control it the discharge reached about 35,000 cubic feet per second down the river. Subsequent to that, the Board received complaints from residents down river that they were being flooded out. This was investigated, and it was learned that the homes of some of these people were not built on their own properties and they were below the normal high water level. This year, 1961, we have had very poor inflow for the past four or five months, to the point that the local inflow to the lake has averaged only about 1,500 cubic feet per second, from storage. We have increased this amount to about 7,000--in other words, we are using the storage for our three plants on the English River plus six more on the Winnipeg. Now this is the problem which Mr. Walkinshaw may not understand--in 1959 we kept the lake high, at 1,166 actually, which is a level which, it has been suggested, we do not go below. We then incurred the wrath of the people downstream, and now, in 1961, when they were quite happy and with no complaints, we receive complaints from the people in the upstream watershed because of low levels.

In Ontario we have many thousands of lakes. The problem we must face is that some of these lakes must be marked for industrial output, which of course, in this case is hydrologic power. Others must be marked for recreation. It is very difficult to combine them. Mr. Baker has made the point that you can't have flood control or other interests without infringing on one or the other.

If we operate the lakes to maintain partial flood control and production of power, the downstream interests are normally quite happy, but if we then reduce the storage through the same thing, then the people on the lakes are most unhappy. This is our problem, and I don't know how we'll solve it.

Dr. Berry:

Thank you very much Mr. Milne. I think you can take the stand, as we so often do, that you can't be right no matter what you do, in public service.

Mr. W. S. MacDonnell, OWRC Secretary:

References have been made to the storage of water in man-made dams. The watershed storage method of nature should also be considered. Each watershed or water production area may pose a different complex of problems, however, one problem in common is that more vegetative cover is needed on the land if our watersheds are to be suitably productive for man's needs. Originally, Ontario's land surface was approximately 90% covered by trees and vegetation. In southern Ontario, at this time, some counties have less than 5% tree cover, while tree cover in the best county may be about 20%. Population pressures in Germany, pre-war, for example, required perhaps the most intensive land-use practise in Europe, and yet about 30% of this country's land was firmly maintained in tree cover.

Now, one reason why we need dams, is that we do not have enough tree cover. The debris from forests of trees over a period of years forms a thick porous layer over the land, providing a vast sponge-like effect for soaking up rainfall. Tree roots break up the soil and water percolates into the sub-soil to form our reservoirs of ground water. As pressure points occur the water rises to form springs and out network of lakes and rivers are created. This is nature's method of holding and producing water. Why don't we use Mother Nature to the full extent and assist in holding water on the land where we need it? It is much less costly in the long term. More vegetative cover on the land will also reduce the erosion and silting problem and produce many other important benefits as well.

Dr. Berry:

Thank you. We are getting some very interesting information on this topic.

Mr. Walter L. Rice, Ontario Department of Public Works:

When the Department of Public Works rebuilds dams in Ontario, we invariably construct them with 25% to 50% more discharge capacity than formerly. This is done in order to take care of the increased flash flow runoff caused by the denuding of vegetation in the area, and the so-called progress of civilization. I would like to see the restoration of forests and other vegetation wherever possible, in order to conserve the water, and thus make it unnecessary to increase the discharge capacity of dams to get rid of it, with its consequent danger of flooding the areas in the river below the dam.

Dr. Berry:

Thank you. I would like to continue this one indefinitely, but we must turn our attention to some of the other subjects. Now, we shall discuss "Financing of sewage and waste treatment". We have received a few questions in relation to this. The first asks: "What do you consider to be the most equitable method of financing sewage treatment and how should these items in the rate be related?" I am sure it refers to water rates.

Mr. Norman Grandfield, Manager, Public Utilities Commission, Brantford;

Mr. Chairman, we don't like putting it on water rates. I don't think that anyone likes to bill for one particular commodity the charges that were not there before. Not that they are not equitable or that it isn't the right place to put it, but generally speaking, the people do object to paying for it. This is better still. It becomes a little more readily collectable because it is a smaller proportion of the larger bill and that makes it a little easier to pay. However, to get back to the point, we do agree with the city engineer, Harry Richards, and the members of the council, that this must be paid for. It seems logical that the quantity of water that a person uses should bear some measure in relation to their contribution in the cost of sewage treatment. I think we did do something a little different than was done in other places, by establishing a flat rate for sewage treatment charges, based upon the size of the metered installation on the water, rather than the meter reading. In other words, we saw no reason why we should restrict the water use in the City of Brantford by imposing upon it a high sewage charge for water that never got back to the sewage treatment plant. So, in our discussions with the city, we did arrive at this conclusion and I feel that it is equitable and, besides that, it does produce a fixed figure of revenue. If you have a dry year or a wet year, the water works might take a beating, but the sewage treatment plant doesn't, and I think Harry Richards is pleased that we did come to this conclusion. However, other than that, I think that it has been working very satisfactorily. We have had to increase it once, and I haven't had a call about it, so apparently it must be a very small percentage of the water bill, actually, it is 48% of the minimum bill.

Dr. Berry:

Thank you, I knew that Brantford would have the answer. Harry, do you want to comment further?

Mr. Richards:

They have a flat rate for domestic consumption but the industries pay 48% on the water bill, or water consumption.

Dr. Berry:

I have Mr. ~~Sex~~smith as the next speaker on this subject.

Councillor G. Sexsmith, Niagara Falls;

In 1958 the Township of Stamford opened negotiations with the Ontario Hydro for a Pollution Control site in the north end of the township adjacent to the old Hydro Electric Power Canal. Soon after the neighbouring municipality of the City of Niagara Falls was invited to join Stamford in a joint pollution control project. A committee of the two councils was formed and a consultant hired in 1960.

The problem of financing sewage works of the magnitude estimated by our Consultant, H. G. Acres & Company, Limited, is our responsibility and we will be required to raise substantial sums of money for this purpose. The costs involved in building and operating sewage works are as follows: (1) capital cost of construction (2) cost of operation, maintenance and depreciation.

The capital cost of construction must be paid during the construction period and it is intended to pay this cost over a 20 or 25 year period by debentures using the "annuity bond" method. It is my belief that a municipality should debenture for as short a period as their financial condition will allow, because of the excessive interest charges. I further feel that all land serviced by this pollution control plant equally benefits and in view of this I anticipate we shall be charging the majority of the capital cost directly against the assessed value of the real estate serviced by this plant.

The operating cost of this plant will possibly be charged against the users in the form of a surcharge added to the water bill. Under this system a rebate may possibly be made to industrial users who use water for coolant or other similar purposes, such water being discharged into someplace other than the sewage system.

In summing up, I would like to submit the following:

- (1) a municipality should issue debentures for as short a term as they are financially capable.
- (2) that the capital cost of construction be levied against the assessed value of the area serviced.
- (3) and that the operating expenses be charged or associated with the water rates.

These methods which I have outlined for the financing of our joint sewage treatment plant are still only in the formation stage, but I anticipate that in the near future we will be able to have something more definite along these lines.

Dr. Berry:

Thank you. So you see in this case, this is an instance in which the township takes over the city, as far as pollution control goes. You will notice that he uses the more modern term, Pollution Control Plant.

The second question is, "What measures are needed to reduce treatment costs." This is an interesting one.

Mr. D. S. Caverly, Assistant General Manager, OWRC;

The cost involved in the treatment of sewage and other wastes comprises two main sections, (1) Capital Cost, and (2) Operating Cost.

(1) Capital Cost

The design of any treatment works involves a detailed study of the degree of treatment required to satisfy local and other conditions and the higher the degree of treatment selected, the higher the capital cost will be.

Reduction in capital costs may be effected by:

- 1) The development of more economical and less expensive treatment installations including improvements in the activated sludge process, the development of oxidation ponds and techniques of spray irrigation.
- 2) More careful consideration of treatment plant location, giving practical consideration to properly laid out works and resulting improved flow pattern.
- 3) Undertaking further research in the field of operation to avoid expensive reconstruction and to make intelligent provision for smooth and orderly plant expansion at minimum cost.

(2) Operating Cost

The cost of operating a treatment works will generally increase with the size of the plant and with the degree of treatment provided, however, careful attention to a number of items can keep these costs to a minimum.

Employing operators of high calibre is more economical in the long run as more efficient operation and better equipment maintenance is achieved. One of the aims of the OWRC is to employ sufficient staff of high calibre to ensure proper operation and equipment maintenance.

Intelligent use of automatic controls can reduce the man hours of required supervision, e.g. automatic sludge pumping from primary clarifiers to digester. However, there is a tendency to over automate which often

results in unsatisfactory operation and also involves a needless capital expenditure. No treatment works can operate without human supervision and it is better to have an operator working at process control than merely watching automatic dials and recorders. Nevertheless, there are occasions where full automation gives decided advantages, e.g. the control of a series of sewage pumping stations is more economical under automatic control and leaves the operator free to concentrate on process control. Great differences are encountered in equipment maintenance costs due to location of service agents, cost of spare parts and availability of spare parts. Careful consideration to these items in the selection of equipment will help to reduce operating costs.

The problem of major concern to all in the field of sewage and waste treatment is efficiency of operation and its improvement. Throughout the treatment process, there are areas where operational efficiency can be improved.

- a) Fuel costs can be reduced by close control over digester operation to produce good quality digester gas.
- b) Attention should be given to electrical power factors which is significant in larger plants where high peak demand of power occur. Investigation should be made into the possible use of capacitors.
- c) The use of blowers to provide the compressed air supply to the aeration section and account for the majority of the overall plant power consumption. A test to measure the concentration of dissolved oxygen is used to govern the unnecessary use of these blowers and thus effect a saving in power.
- d) The "in plant" cost of handling sludge is directly proportional to its volume and it is therefore necessary to investigate methods of thickening for both raw and digested sludge and reduce the volume to be "held", "pumped", "heated" and "removed."
- e) A major operating cost is in the disposal of sludge. An intensive study is necessary to evaluate the merits and true costs of the various available methods for an intelligent selection of the best and most economical method.

The disposal of sludge is not directly related to the degree of treatment or the quality of the effluent and, therefore, the most efficient and economical method may be selected.

- f) A major portion of the capital investment in any treatment works comprises the machines and equipment and it is essential that the useful life of these items be prolonged. This may be achieved by a planned program of regular lubrication and preventive maintenance to decrease the operating repair costs.
- g) The disinfection of sewage effluents by chlorine is another major operating expense which can be reduced by
 - (i) chlorinating only for the summer months when health hazards are apparent.
 - (ii) purchasing chlorine in sufficient bulk at competitive prices.
 - (iii) investigating more efficient methods of controlling its application.
- h) Careful cost accounting can point out trends of high cost on continuing expenses, particularly where a number of separate operations can be compared. Unusually high costs such as power, chemicals, water, labour, repair and maintenance, sludge disposal and even the cost of housekeeping supplies can best be controlled by making continuous comparisons with other similar installations.

Dr. Berry:

Thank you Mr. Caverly. This is a very interesting subject. The next man to speak is Mr. Smith of Orillia.

Mr. B.E. Smith, Orillia Water, Light and Power Commission, Orillia;

What measures are needed to reduce treatment costs? This question can be broken down into two main headings - reduction of capital costs and reduction of operational and maintenance costs.

When a municipality decides to investigate the expenditure of a capital cost for the purpose of either constructing new sewage treatment facilities or enlarging the old ones, the first phase of cost reduction comes into play.

Usually an engineer is employed to prepare a preliminary report on the scheme. A considerable amount of money can be eventually saved if this report is carefully prepared through extensive studies of the problem. A well-prepared analysis at this point may eliminate initial over-design or under-design -- either of which will result in increased costs in the long run. Adequate preliminary engineering also allows for the most economical staging of subsequent expansions. In particular, the following questions should be answered in this report which affect the cost of the work.

1. Population to be served or design flow over a determined lifetime of the work.
2. Degree of treatment required--whether it be primary or secondary. In most cases the Provincial authority sets certain standards, but in some cases the nature of the receiving stream is a factor in this determination.
3. Type of treatment--such as trickling filters, activated sludge or sewage lagoons.
4. Location of the site of the works.
5. Whether the project is financially feasible.

After it has been decided to go ahead with the project, the engineer undertakes the design and preparation of plans and specifications for the works. Based on conclusions and recommendations of the preliminary report, the engineer is equipped to specify the actual details of the plant. Again I would emphasize that a careful look at each individual project is required. Certain economical practices may be employed in this regard and I think some are at least worth mentioning here.

1. It is generally advisable to locate the grit removal facilities as near the influent end of the plant as possible in order to prevent wear of subsequent equipment due to the handling of the grit. A cost study of mechanically handling the grit versus amount of labour required is suggested also.
2. In many plants a large number of small-capacity clarifiers have been installed, although two or three large units would provide the same treatment efficiency and would eliminate many maintenance and operational costs. I would mention, however, that at least two units are advisable for versatility.
3. Pumping facilities should be made as flexible as possible so that more than one operational procedure can be carried out by the plant personnel at the same time.
4. Sludge disposal is a costly item and the various possibilities should be carefully investigated--whether it be sludge drying beds, sludge lagoons, vacuum filters or any other method.
5. The engineer should attempt to use standard equipment wherever possible to prevent any difficulty in obtaining replacement parts. If possible certain pieces of equipment such as electric controls should be duplicated, so that emergency parts may be interchanged. This reduces spare part supplies.

6. A carefully planned general layout can do much to keep the plant costs down. Certain portions of the plant which are not easily enlarged should be made sufficiently large at the start.
7. The local power costs and other forms of energy should be investigated in order to determine the best selection of equipment.
8. Modifications in the process such as 'step-aeration', 'tapered aeration', etc. should be examined as well as any new trends or new equipment in this field.

We have briefly covered a few of the points that the engineer should consider when preparing the plans and specifications in order to save on treatment costs whether it be in the actual capital costs of the plant or subsequent operation or maintenance costs. The next phase of this question deals with certain measures and procedures which may be taken at the operating level.

The most important consideration here is to obtain competent and trained personnel who thoroughly understand their work and appreciate the problems. The municipality should be prepared to send their staff to courses or lectures where they may learn up to date methods from qualified people as well as meet and discuss problems with other operators.

The operator should procure the proper tools and equipment needed to carry out routine duties and maintain the treatment plant in a satisfactory condition. Regular maintenance of equipment should be carried out and suitable records kept of these operations. The engineers' operational manual and finalized drawings of the plant should be followed. This type of preventive maintenance reduces the costly emergency or breakdown type of repairs.

The operator and engineer should investigate the possibility of improving the operation of his plant. In Orillia, we managed to reduce our operation and maintenance costs by over 30% from over \$2.00 per capita per year to \$1.40 by using sludge lagoons for sludge disposal. Up to that time, we had used a vacuum filter but because of the amount of land which was available to us and the location of the plant, we were able to make this change. The resulting reduction in cost was due to the saving of power, labour, chemical and equipment costs. One other factor which has helped us to a lesser degree is by keeping a careful check on our peak power loads.

It is also advisable to prepare a list of parts which have a high replacement rate such as bearings and gears, and this list should show the manufacturer and part number. In some cases, it may be wise to stock these parts at the plant.

The foregoing is by no means a complete report but merely some of the comments that I have come up with on this question of reduction of treatment costs.

Dr. Berry:

Thank you Mr. Smith.

Mr. Owers:

Dr. Berry, there are a few points which I would like to make to supplement the day's remarks on capital costs.

The first one is quite obvious, and is to develop plans to take maximum advantage of Federal financing assistance under NHA, together with Provincial assistance which may also be available.

The second point which I consider realistic and logical from a planning viewpoint is to put less emphasis on municipal pride and more on the soundness of servicing by considering logical planning areas ignoring municipal boundaries. This is the point to which I referred when I presented my paper on the number of projects that are proceeding under OWRC agreement with more than one participating municipality.

My third point applies more specifically to smaller municipalities. In planning, population forecasts should be considered more carefully. We frequently see figures which are quite unrealistic. I feel that short-term planning, particularly for treatment facilities, is good business.

Dr. Berry:

Thank you Mr. Owers. Anyone else like to comment on this?
Mr. Rice, would you care to remark on this?

Mr. W.L. Rice, Department of Public Works, Toronto;

I'll tell you a little secret as to how municipalities may help pay for extensions to sewage treatment plants and water plants, seeing that there are no senior officials of my Department here. Just invite the Governments to locate new institutions and buildings close enough to your plants so that they can make use of them. If that is done, they quite likely will pay for the extension, rather than construct their own separate plants. The Government engineers concerned with this problem would also welcome the relief from having to plan separate plants.

Dr. Berry:

We now will go on to the third question on the list, "How should these costs be expressed in order to provide comparisons for the rate-payer."

One of the problems I find in talking to groups is the way this is expressed. Do you say that this plant is going to cost two million dollars, or is it going to cost ten cents a week or five cents a week -- and, Don Redfern, I think it was, said last year, "One cent a day keeps the scent away," so there are various ways for expressing this. Would anyone like to comment on this? Would someone like to express their views on any experience that they have had in dealing with the public to inform them of the small cost of sewage treatment? We have used the expression quite frequently that, for the average family it costs less than the price of one gallon of gasoline per week, and that is the lower grade of gasoline.

Mr. Caverly:

I had an idea that this might come up. We did some tabulation of our own operations, and converted it into just this figure that you mentioned. We put it down as cost per capita per day. In the plants that we are operating, we have encountered a low of two cents for a primary plant, up to a high of nine cents in one of our more difficult activated sludge plants, and it appears as though our figures approximate a cost of five cents per person per day for treatment. This is operating cost only--not capital repayment.

Dr. Berry:

I hope the results from the various plants can be expressed in some uniform way such as this, and it will indicate then just what can be done and what these plants are costing.

Another way of doing this is to express it in terms of a laborer's average age. How much time per week does he work for the payment on the cost of the sewage treatment plant, including the capital and operating costs? I calculated that in one municipality it was about seven minutes of his time per week for his whole family. Any other comments on this topic? Well, then, let's get on with the next one, "The industrial waste by-laws for municipalities." You will see that we have two questions under the one topic, the first one being, "How can uniform requirements for accepting industrial wastes into public sewers be attained?" I think that we have seen from the papers here, just how this would work, the need for it, and how we are going about it to attain that.

Mr. R. O. Bambrough, Technical Superintendent, Dominion Tar and Chemical Company Limited, Toronto;

Personally I do not think that a uniform by-law for the discharge of industrial effluent into municipal sewers is desirable. The laying down of acceptable standards should be a matter of joint negotiation between the industry and the municipality concerned. It is no good setting impossible limits for the discharge of industrial waste into sewers and telling industry it is their problem to meet these limits. By the same token, industry could turn around and say "you asked us to locate in your township and we pay our taxes, this is our effluent and it's your job to treat it." Neither attitude will lead to a solution of the problem.

In the proposed by-law which has been put before this conference two of the provisions are:-

- (a) No cooling water may be used for dilution of contaminated effluent.
- (b) The concentration of phenolic bodies shall not exceed 50 ppb.

As there is no commercial effluent treatment plant in existence which will consistently produce effluent with a phenol concentration of 50 ppb dilution becomes essential to meet the requirements of the by-law, this in direct contravention of the by-law.

However, I feel that this is not the right solution. Surely it is much better to consider contaminants by quantity per day. Industry would, I feel sure, be quite happy to meet realistic requirements of contaminants in their effluent if it were based on so many pounds of contaminants per day per 100,000 gallons capacity of the local sewage plant. This would lead to a reduction in the volume of effluent treated at the sewage plant, and hence in its capital and operating costs.

If, to meet unrealistic requirements of a by-law, industry had to dilute effluent streams 1000:1 any sewage plant and sewer network would become obsolete overnight.

Not many years ago the limits for the discharge of phenols was 1ppm which was the lowest limit that the chemists could detect with certainty. Now the chemists say they can easily detect 50 and even 2 ppb. With this last figure I cannot agree. The proposed by-law appears to be based on the testing ability of the chemist and not on the efficiency of the local sewage plant. At some future date are we to have this by-law amended when the chemists think that they can detect 2 parts per trillion?

The problem, gentlemen, in my opinion, can best be solved by both sides being reasonable. Industry doing any necessary pre-treatment at the plant, and the municipality accepting so many pounds per day of contaminants into the municipal sewer.

Dr. Berry:

There might be room for considerable discussion on a comment of that kind, but I think that it is a question of whether the standards or requirements are adjusted properly rather than dealing with them to suit the horse-trading, as you put it. However, without going into that now, Fred Voege, would you like to comment on that?

Mr. F. A. Voege, Director, Division of Laboratories, OWRC;

Mr. Chairman: Contrary to Mr. Bambrough, I am in favour of uniform requirements providing that they are conditional, and I would just like to read a few notes that I have here regarding this question.

Before any requirements, uniform or otherwise, for accepting industrial wastes in the public sewers can be attained, the need for these requirements must be demonstrated. I think that this need was clearly demonstrated in Mr. Harris' paper of earlier this afternoon.

If industrial wastes can be the cause of these effects and other detrimental ones not mentioned, and we are quite certain that they are or can be, some means must be set up to minimize these effects or eliminate them completely. This is where the requirements for accepting industrial wastes in the sewers are needed.

However, it is necessary to go one step further. It is necessary to know at what levels and concentrations these wastes have the effects mentioned before on the sewers and treatment plants. This knowledge comes firstly, from determining the cause of certain effects on the sewers by experience, and, secondly, through research into possible effects of certain wastes. Research makes it possible to determine the effects before they manifest themselves in or on the sewers or sewage treatment plants, at which time it may be too late. A search of the literature will reveal whether any of this research or these experiences have taken place elsewhere and what the results were. Information should be gathered to determine the normal constituents of domestic wastes and their concentrations since we are all agreed that industries need not reduce their concentrations below these figures.

When all the data has been gathered concerning cause and effect, it should be possible to list the various requirements that satisfy the facts proceeding from a study of this data.

This presentation of the list of requirements can be done in various ways. Certain uniform requirements can be listed for certain conditions either in the sewers, or at the sewage treatment plant. A change in conditions in the sanitary sewers regarding the materials used for construction or connection can change the requirements for pH, temperature, and solvents. The type of treatment provided at the sewage treatment plant

now and also in the future will dictate the amount of treatment the waste should get before it is discharged to the sewers. Consideration should be given to the possibility of having to limit the volumes discharged so that dilution cannot be used to bring concentrations to within the requirements.

In certain localities, a certain combination of wastes, e.g., cyanide wastes and acid wastes and certain gel formers, can cause difficulties that would not arise if the wastes were discharged into different or separate sewers. This aspect must be considered.

Once the local difficulties in the sewers have been cleared up the next question is the character of wastes reaching the sewage treatment plant. If the concentrations of the constituents in the raw sewage are such that the waste will be difficult to treat in the plant, it is necessary to reduce the amount being discharged by the individual industry and uniform requirements should then be requested. In all this fact finding and information gathering, the help of industry should be solicited since their help and cooperation will be needed to make any ordinance concerning these requirements a success.

When all these aspects have been considered it should be possible to set requirements for the discharge of industrial wastes into public sewers in the municipality and make them uniform for all the industries in that municipality so all are treated equitably. These uniform requirements are the result of careful study on the results of experience and research. Since research is continually going forward and producing more information, improving materials and methods, determining more causes and effects, and experience is piling up more data, these requirements should not be considered permanent but able to be altered when necessary to conform with the latest information.

Since many municipalities have not the means for doing this research or making a literature search, or have had limited experience or data regarding industrial wastes, they would find it difficult to set requirements to meet their needs. I feel sure that the Commission in general and the Industrial Wastes Branch particularly, would be very glad to assist them in anything in this regard.

* * * * *

As the time was drawing near to closure, a number of persons were unable to speak on this subject. However, several written comments were received following the conference and these are inserted as follows:

Mr. A.C. Elliott, Superintendent, Utilities Department, The Steel
Company of Canada, Limited, Hamilton;

As a general policy, we feel that the practice of admitting industrial wastes in municipal sewers is recommendable, providing that such wastes do not affect the efficient operation of the municipal sewage treatment plants. Certain industrial wastes may be classified as a nuisance in all cases, and their admission to municipal sewers should be prohibited. It is economically unreasonable to reduce the efficiency of a multi-million dollar plant by attempting to treat industrial wastes which could be more expediently treated elsewhere.

However, certain industrial waste may or may not be detrimental to the operation of a treatment plant, depending on the type of treatment facilities available. In some instances, the industrial wastes to be treated may exceed the domestic sewage load, and under these conditions, it may have been deemed practical to incorporate the industrial waste factor in the original design of the treatment plant.

In view of the above, it would appear that uniform requirements for all municipalities would be impractical. The needs will vary from one locality to another and on this basis, we suggest that each municipality be dealt with individually. It would appear logical to us that the OWRC, with the experience it has gained in this field, be responsible for advising the individual municipalities of the requirements in their by-laws.

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Mr. G.H. Baker, Industrial Commissioner, Township of North York,
Willowdale;

With reference to the question "What should be the policy of municipalities dealing with the treatment of industrial wastes?", I was going to make the following remarks:-

The writer can offer comments on this question with a background of experience as a municipal officer responsible for the design, construction and operation of sewage disposal plants and as such, became familiar with the problems of successfully operating a municipal plant. For the last half dozen years, however, I have been engaged in directing the efforts of the Industrial Development Section of the Township organization and during this experience I became familiar with the attitude of industry in general, which presents another side of the picture.

I have learned from business men that the attitude of industry, singularly and collectively might be summarized as follows:

Industry provides jobs, employment, prosperity for the country and community, it produces the services and goods required for the life of the nation, and also produces the products for export to build up favourable trade balance. It pays in general, over half of the profits to the Federal Government in taxes, and pays municipal taxes at a higher rate and at a greater ratio of assessment than other sectors of the assessment roll, including school taxes without directly using the school facilities; and in addition pays a fairly heavy business tax. It is the opinion of industrialists that, as they pay into the municipal tax structure the normal levy for sewage disposal services, that the community should assist them in the treatment of industrial wastes.

I believe that under the present status, the only workable policy for the municipalities to adopt is to be protected by a controlling by-law which gives the corporation the undisputable right to accept only that liquid industrial waste which the sewerage system can accept without injury or deterioration to the pipes, and which the treatment plant can absorb without interfering with the efficiency of the treatment process.

This policy, however, will in due course, become obsolete and I feel that in the future it will be only fair that a public treatment system be constructed and operated to accept industrial waste for treatment, on some mutual agreement, and charge a fair levy for the services.

I would also go on to suggest that in the near future, it should be the obligation of the Ontario Water Resources Commission to set up special treatment plants for handling industrial waste where the problem becomes acute, because the Commission is in the best possible position to render efficient service for this particular need of industry.

It might also be suggested that the time is not far distant when by a planning procedure ordinance certain industries producing problem industrial waste should be located in several central areas where the treatment problem can be localized by proper treatment facilities under the guidance and operation of the Ontario Water Resources Commission.

* * * * *

Mr. J. Cruickshank, P.Eng., Township Engineer, Township of Thorold;

All municipalities have industrial development committees, to entice industrial companies to set up operations in their particular municipality. Therefore it should be the responsibility of these municipalities to treat the industrial wastes from these industries where possible.

As to whether this is feasible, each industry must be examined on its own merits. Naturally there are many types of wastes which should be excluded from the sewers and treatment plant because of the injurious effect of the wastes on these structures.

This it is necessary to make an analysis of the wastes from each industry.

The municipality may set a policy on what they will not allow into the sewers in any quantity, and maximum limits on certain chemicals which in small amounts do not cause harm to the sewers or plant.

With a policy now set, and reports available on the analyses of the communities industrial wastes, the municipal officials can now sit down with the officers of each industry and discuss what pre-treatment, if any, should be carried out by the industry before depositing their wastes in the municipal sewer system for treatment.

Because of the nature of the waste, it may be necessary for the industry to undertake its own complete treatment, by means of mechanical equipment or waste lagoons.

Whichever direction is taken in the disposal of industrial waste, it is necessary that there be close co-operation between a municipality and its industry, and one factor which is ever prevalent in setting up policies is how much it will cost both the municipality and the industry for treatment of these industrial wastes.

* * * * *

Mr. R. C. Beal, Manager, Engineering, The British American Oil Company Limited, Toronto;

For many years it has been customary for the petroleum industry to treat all of its industrial wastes, and in most cases its sanitary wastes, within the refinery. In the case of the British American Oil Company, only two of our six refineries discharge even sanitary wastes to municipal sewers. The reason for this has been that all refineries generally have been built out in the country where no municipal services were available. In addition, in most cases the flows of effluent water were very large and would over-tax the capacity of most municipal systems.

This situation is rapidly changing since housing developments are now being built to surround oil refineries, and municipal services are being installed. Also, water conservation practices and improved operating conditions have reduced oil refinery effluents to quantities which would be suitable for discharge to a municipal treating plant. Municipal waste disposal plants with large flows, high dilution, and skilled supervision should be able to offer more economical treatment than a multitude of small industrial waste disposal plants.

We deplore the tendency for municipal by-laws to accept almost any kind of industrial waste except phenol. It would appear to us that a municipal plant can treat phenols in activated sludge equipment as readily as industry. It might be necessary to install pre-treatment facilities to ensure a uniform flow of phenol so as to prevent shock-loads on the municipal plant.

We believe that municipal by-laws should include provisions for the following:

1. Industry should be charged for treatment of their industrial wastes. The charge should be established on an equitable basis which would recognize the assessment and the taxes paid by industry, with a surcharge for additional quantities beyond a quota. When the rates have been established, industry can make economic studies to determine to what extent they will use the services of the municipality.
2. New connections from industries should include facilities for measurement of flow and for obtaining representative samples.
3. Industry should be required to install such pre-treatment facilities as would be required to ensure uniform flows of industrial wastes which will not put excessive shock-loads on the municipal plant.

* * * * *

Dr. Berry:

The next item for discussion is the subject of water quality management problems, No. 7 on the program.

Mr. T.B. Borgford, Engineering Department, Canadian Industries Limited, Montreal; answers the question, "What would you consider to be the greatest problem today in water quality management?"

From our experience in C-I-L, the greatest problem in water quality management is due to sudden unpredicted great changes in the quality of the raw water. This change in the quality may be in the chemical constituents of the water or it may be a physical condition such as a sudden rise in the water temperature.

Incidents that have occurred at three different C-I-L plants will serve to illustrate this problem as it applies to the industrial use of water. At one plant the raw water is obtained from wells. For six years the wells produced water having about 260 ppm total solids and 240 ppm total hardness.

Then in a short time the total solids increased to 575 ppm and the total hardness 430 ppm. It took several months for the quality to return to normal. In the meantime great difficulty was experienced in treating the water with the regular softeners to provide the powerhouse boilers with an acceptable quality of water. We have not been able to account for this sudden change in the quality of the ground water.

At another plant we have a recirculated cooling water system with an evaporative cooling tower. Normally the recirculated cooling water is treated to provide 1) protection for the wood in the tower, 2) protection of the metal in the system in contact with the water and 3) to maintain satisfactory heat transfer coefficients on the water side of the heat exchangers. However at this plant the cooling water becomes so badly contaminated from airborne pollutants that we are unable to achieve all of these objectives. The airborne contaminants enter the system through the cooling tower which acts like a big air scrubber. In this case we can think of the water as it passes through the tower as being the raw water and that its quality can change depending on atmospheric conditions.

We obtain water from Lake Ontario at another plant where it is used largely for cooling and air conditioning. We have experienced sudden warming up of the lake water which presents process problems. This warming up has taken place even though the intake is 2000 ft. from shore and is in 105 ft. of water. The water temperature rose from 55°F to 65°F following several days of wind blowing on shore from a special direction. Apparently the warm surface water was driven by the wind along the surface to the shore. There it piled up, so to speak, and displaced the colder water at lower depths till finally there was a mass of warm water extending from shore to beyond the intake. From our point of view, the raw water quality deteriorated when it warmed up. Fortunately such a condition can improve almost as quickly as it deteriorated.

These three experiences are examples of sudden unpredicted great changes in the raw water quality which give us the greatest problems in water quality management.

Mr. G. M. Galimbert, Assistant General Manager, OWRC, answers the questions, "What is the best procedure for dealing with sewer outfalls, both in sewered and non-sewered communities? How much use should be made of septic tank systems?"

This is a three part question that must of necessity be separated into its three separate parts.

1. What is the best Procedure for Dealing With Sewer Outfalls
In Sewered Municipalities?

Outfalls must be located with due regard to prevailing currents and their bearing upon water works intakes and bathing places. In some instances protection against floating debris, drifting beach sands and ice may have to be provided.

River outfalls must be installed so that the effluent reaches the diluting water and is carried away without objectionable conditions being created. In a river this would require that the outfall pipe is carried to the main flow of the river and not placed close to shore so that sewage is carried by shore eddies to bathing beaches or water supplies below.

Lake outfalls should be installed so that the effluent is carried to a sufficient depth of water that no deposits will occur on the shore of the lake. Every precaution should be taken to assure that the location is such that the prevailing currents will take the sewage effluents away from water supplies or bathing areas. This is sometimes difficult to achieve if water works are located in both directions from the proposed outfall site.

The tremendous residential and industrial development that has occurred in Ontario has caused the installation of lake sewage outfalls and water works intakes in recent years in closer proximity to each other than ever before. Under such circumstances it is essential that the intake be extended to a greater depth into the water and that the prevailing currents be given special consideration. The same approach must be made in the installation of outfalls and intakes for institutions and industries where the waste discharge must be made in relatively close range to the water works intake.

2. What is the Best Procedure for Dealing With Sewer Outfalls
In Unsewered Areas?

There are no outfalls in unsewered areas with the exception of storm drains. In this case it is essential that every effort be made to prevent discharge of sanitary or industrial wastes to the drain and to keep the drain for the purpose that was intended. This is a difficult thing to do in an unsewered municipality. It requires careful policing by the local authorities. Sometimes it is almost an impossibility to find such sources of contamination to drains in unsewered municipalities.

3. How Much Use Should be Made of Septic Tank Systems?

Septic tanks are an essential type of sewage disposal in an unsewered municipality. If installed properly in suitable soil they will give satisfaction for many years of operation. On the other hand if they are installed improperly in unsuitable soil they will result in very objectionable sanitary conditions.

Septic tanks are a cheaper alternative to sewers and sewage disposal. Their use is required in certain instances, but, in built-up areas, particularly with difficult soil conditions or in new large subdivisions their installation should be discouraged. In fact it is now difficult to obtain financing for large subdivisions where the house will use septic tanks instead of sewers.

Dr. Keith L. Murphy, Assistant Professor of Civil Engineering and Engineering Mechanics, McMaster University, answers the question, "How can industrial wastes be controlled to prevent interference with water quality? To what extent should research be carried on in the field and by whom?"

This question carries with it the implication that the introduction of industrial wastes does cause a degradation of water quality. This is reasonable as almost all activities of man influence the "status quo" of water resources. The complete exclusion of industrial effluents is readily seen to be impractical and the question to be considered is the extent to which industrial effluents are to be discharged to the water courses of the province i.e., what limits and standards are to be maintained.

Industrial wastes are of many types. Some contain biological contaminants, unstable material which utilizes the dissolved oxygen of the receiving waters in the natural process of purification. Others contain inorganic contaminants i.e., acids, alkalies, toxic salts of mine and plating wastes; nutrients such as nitrogen and phosphorus; or organic chemical exotics such as syndets, insecticides, herbicides and petroleum derivatives. Still others may contain silts, radio-active wastes, or Heat.

In order to prevent serious depletion of water quality, wastes containing these pollutants can be tolerated only to a limited degree. The establishment of limits or standards for the discharge of these wastes constitutes the first step in the control of possible impairment. The OWRC has presented to the participants at this conference a set of standards which when examined are seen to conform with the best data currently available. Particularly in the future with the anticipated increase in pollution, it is necessary that we have complete confidence in the control standards not only to prevent interference with water quality but also to avoid needless expenses or hardship resulting from excessively stringent requirements.

At the National Conference on Water Pollution held in Washington D.C., on December 13 - 14, 1960 and called at the behest of President Eisenhower, several speakers from industry and regulatory agencies questioned certain nationally accepted standards and indicated the need for more research. For example it was mentioned that intensive investigation undertaken several years ago failed to divulge any adverse effects in drinking water or corrosion patterns when chlorides were present in excess of 250 ppm. The use of coliform organisms as an indicator of the probability of exposure to pathogenic bacteria was questioned. This criticism was based in part on the ubiquitous nature of the coliform organism and in part on the possibility that a change in that ratio of coliform to pathogenic bacteria has occurred since the conception of this testing technique. Similarly the use of one tenth of the 48 hour TL_m as a safe toxicity limit as proposed by ORSANCO does not take into account the synergistic and antagonistic effects of receiving waters or the effect of long term exposure to toxic materials.

Once the standards have been investigated, the methods of treatment available may be considered. Currently, conventional treatment methods can be utilized economically only for relatively low concentration organic wastes free from toxic materials. Even these processes are not fully understood and designers must resort to low loadings and high safety factors both of which contribute to high treatment costs. The problem of removal of nutrients and the complex organic materials recently introduced into waste streams in ever increasing quantities has not been economically resolved. It would seem logical to expect tertiary treatment will prove necessary for removal of nutrients and organics. Further research in this area is certainly required.

It is apparent that if successful control of industrial wastes within province is to be obtained, a conscientious research program must be implemented. Funds must be provided to universities, research foundations and to the OWRC to investigate the problems outlined. In addition, industry must be prepared both through financial support and actual research to justify to the people of the province that industrial effluents will not seriously alter the quality of the water resources of the province.

Mr. A. L. Van Luven, Vice President, Quebec Water Purification Board, answers the question, "How can industrial wastes be controlled to prevent interference with water quality?"

I would first like to stress that fundamentally I am a conservationist who, in fact, has invested a considerable sum in reforesting my own land. Therefore, I want action on industrial waste soon, however, a reasonable approach will produce much better results a great deal sooner. Therefore, I think the following principles should be used, and control will be achieved by:

1. Cooperative thinking and acting by all levels of governments and by industry.
2. Realistic attitudes so that both sides accept certain basic and essential concepts such as the following:
 - a) Industrial wastes should be controlled to the full extent that it is technically feasible to do so, providing that no industry is placed in a non competitive position in either domestic or foreign markets.
 - b) The principles of true conservationism should be adopted on both sides. These principles include "use as well as saving" and "development as well as protection".

The foregoing concepts underline the necessity to impose anti-pollution controls over very wide areas - preferably nation-wide, keeping them comparable but not necessarily identical. In addition, true conservationists will not object to using some of the waste-assimilating capacity of streams and, by the same token, industry and others should reduce consumption wherever possible.

3. Adoption of methods that are in keeping with the wastes to be handled.
4. Developing methods of measurement and analysis that portray the picture correctly and by trying to understand the short-comings with some of the existing methods.
5. Developing active Government-Industry Action committees that will discuss objectives before these are declared by governmental agencies.
6. Developing objectives that meet the needs for some time in the future as well as in the present.
7. Careful assessment of surface and ground water conditions.
8. Adequate housekeeping and "In-plant" waste control on the part of Industry. For example, it is frequently possible to improve their facilities for segregating wastes, so that certain wastes are more easily treated before discharge to a sewer system.
9. Industry, in general, achieving a satisfactory degree of preliminary treatment prior to discharging their wastes to municipal sewer systems. If they are discharging directly to public courses then, of course, we can substitute the word "adequate" for preliminary.
10. Developing realistic By-laws, including surcharge systems wherever these can be developed readily; they are only applicable, of course, to industries that use municipal sewer systems.

11. Employing joint treatment for industrial and municipal wastes, wherever this is practical. It is realized that some industries are seeking to develop "closed process systems" and they would not like joint treatment.
12. Constructing S.T.P. that are capable of handling reasonable industrial sewage loads, with the understanding that shock loading (both hydraulic and organic) would be avoided by suitable facilities at the industrial plant.
13. Requiring all industries to accept the principle that waste treatment is part of the cost of production.

Research on Industrial Wastes

The need for research and/or development on industrial wastes is evident from the fact that, in our recent E.I.C. - C.I.S.S. survey, approximately 25 areas of possible research activity were suggested for the industrial waste field alone.

Research, By Whom

In the report to which I have just referred, the suggestions have been quite varied.

Many believe that the Industry concerned should do their own research because it is necessary to understand an industry well before trying to solve its waste disposal problems.

Others, well acquainted with the Industrial problems, believe that the Federal government ought to do the research. This view is quite strongly held by some, when speaking of municipal waste.

Some very informed people think these problems should be handled by a system of Federal grants to the existing self-governing research organizations, such as Ontario Research Foundation and the Provincial Research Councils.

Mr. G. E. Trewin, Sanitary Engineer, OWRC, answers the question, "What is the most effective program for surveys of water quality, standards to be met, and administrative procedure for regulating water quality in any stream or part thereof?"

The question can be considered under three parts:

1. An effective programme for the evaluation of the condition of a body of water; stream, lake or pond;
2. What criteria should be used to evaluate the stream's condition;
3. Methods of regulating or controlling pollution.

1. A routine sampling programme, timed according to need, can be formulated to develop a continuing picture of the water quality in a given body of water. In border line situations, biological observation in relation to bottom fauna can be included with the sample results and visual observations to complete the picture.
2. The criteria used to evaluate the condition of the stream are many and here again the number of tests to be performed will depend on the need. A simple survey might require the collection of one chemical and one bacteriological sample from each control point with the following tests being made:
 1. 5 Day B.O.D.
 2. Suspended solids, or turbidity if s.s. low.
 3. Coliform count per 100 ml.

Tests that can be added according to need are:

4. All nitrogens.
5. Dissolved oxygen (made on site).
6. Colour.
7. Phenol.
8. Other chemical constituents as required.
9. Biological examinations.

The two simple criteria limitations set for the primary programme are that the B.O.D. should not exceed 4 ppm and that the coliform count not exceed 2400 per 100 ml. In critical areas D.O. determinations might be made and here it is difficult to set one limiting factor. To present a complete picture the dissolved oxygen determinations should be made on a 24 hr. basis. Time limits the extent of our considerations of the many other criteria used to evaluate the conditions of a body of water.

3. To provide for pollution control concentrated municipal pollution surveys are recommended. In these surveys all outfalls are located and sampled. Routine inspections also should be made of municipal and industrial waste treatment plants to ensure that they are effecting their intended purpose. The individual surveys must, because of the extensive nature of the work involved, be limited to one municipality and in the case of areas such as Metropolitan Toronto, a survey could cover say, one watercourse within the given municipality.

Mr. K. E. Symons, Surface Water Supervisor, OWRC, Division of Water Resources, answers the question "What is the most effective programme for surveys of water quality, standards to be met, and administrative procedure for regulating water quality in any stream or part thereof?"

An effective programme for surveys of water quality must provide the necessary information for wise decisions by the administrative agency. Therefore the programme must provide the answers to the following questions:

1. What are the present sanitary conditions of the stream?
2. What are the amounts and qualities of effluents being discharged to the stream?
3. What are the hydraulic characteristics of the stream and the hydrologic characteristics of the watershed?
4. What are the sources and present uses of water from this stream and in the area?
5. What future developments and requirements can be expected in this area?

The unit of the survey may be a complete or partial watershed or a geographical unit such as a municipality or a county. The Commission has used all these units in conducting surveys. The county unit has merit because it provides an area of reasonable size for the survey and also provides an existing organization for promoting and initiating remedial actions where such are found to be necessary.

In a limited survey to investigate a specific condition or problem and where clean streams are being investigated, the survey may be confined to investigations which would answer the first two questions - stream and effluent quality. However, comprehensive coverage is desirable in industrial and urban areas and where rapid development is taking place.

The survey must therefore include:

1. Stream sampling.
2. Effluent investigation and sampling - this includes municipal, industrial and special discharges.
3. Examination of stream flow data - consideration of minimum flow, storage and existing or potential regulation.
4. A survey of all water uses and withdrawals in the area for municipal, industrial and agricultural purposes and with respect to recreation.
5. An examination of the development pattern of the area and a prediction of future water requirements.

The type and frequency of sampling and the extent of the analysis conducted should be as complete as staff and laboratory facilities will permit. Standard sanitary chemical and bacterial analyses may be supplemented by additional field and laboratory analyses to serve specific needs. Aquatic biological surveys, carbon filters and spectrophotometry are some of the special tools that can be used.

The question of standards for water quality vs. stream classification has been discussed to some degree already at this conference. Classification places a legal status on the degradation of a stream whereas, objectives can be set which, with wide administration, can be flexibly interpreted to permit the best use of the available water resources. Copies of the Commission's publication, "Water Quality Objectives", have been made available at this conference.

When the survey findings have been assembled and examined and the pertinent recommendations prepared, the finalized report is submitted to municipal and other interested parties. Where remedial action should be taken, the responsible party is notified. This is followed by both office and field review of the actions being taken. Where lack of effort and co-operation are noted, firmer action may be necessary.

In summary, comprehensive water resources surveys should form the framework within which water quality surveys are conducted. A significant problem here is the time and staff required to complete these comprehensive surveys and reports. Surveys of a limited extent have a distinct advantage in this regard.

The legislative powers of the Commission to control the quality of effluents and the quality of surface waters and to regulate the new use of water for most purposes by permit are important factors in administering a water quality management program.

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Mr. Snider:

This part of the program will give us an opportunity to make an analysis of what has been done at this conference, the conclusions reached, and what can be expected in the future. We are anxious to know, naturally, what you think of this conference. We want to know if you think it is worthwhile, if you have learned something, if it has been to your advantage to have been here, and if we should continue conferences of this kind. Last year it was almost unanimously approved that we have another one this year. Now we would like to hear from some of you if you feel this one has been a success. The enrolment of 250 attests to the keen interest in the work of correction of pollution and pollution control and water management. I hope we were correct in our impressions of the enthusiasm for this type of conference. Now, if anyone would care to open the discussion, now is the time to do it.

Mr. Charles Huffman, Ontario Federation of Agriculture:

Mr. Chairman, may I congratulate you and your board for arranging such a fine program as we have had for this last two days. May I be very brief in suggesting that I hope you will have other conferences in the future, and that Agriculture may play a little more important part. I think it is very vital that we make Agriculture play its role.

Mr. Snider:

Thank you very much.

Mr. Don Redfern:

Mr. Chairman, I think these conferences do have a lot of value. I think, however, there is always a tendency when you have had them for two or three years, that you start to repeat what was said a couple years ago, maybe in slightly different language. I believe the prime purpose of this conference probably is to keep it on a general level with its name, but I think we should try to derive any specific benefits that are possible.

Now this question of research. I am surprised at the apparent lack of funds the Commission has which could be used for research. I think, indirectly, the Commission could probably spend \$50,000 to \$75,000 a year on the applied research angle. But it is my understanding there is absolutely no dollars put into research as a prime function. So I am therefore suggesting, and I don't know if a conference like this could do so, but I am suggesting a resolution be placed before this conference and a recommendation go to the Ontario government from the conference, that the Ontario government allot monies during this session for research. I can think of no better program than the long range program I suggested on the Grand River and whether we want to or don't want to get into stream classification. So if there could be a resolution entertained, I would like to make that resolution.

Mr. Snider:

We have a program ahead of us, we are going into research and we do intend to put money in it. I would feel we would be remiss in our duty if research wasn't one of the most important parts of our plan. We must have research. We've talked it over, the Commission has approved of research. I think we could find the money to do this research without too much difficulty.

Mr. Redfern:

I think, Mr. Chairman, my remarks were directed to the fact that if the Commission felt an endorsement by this conference to the government endorsing a request that the Commission get additional monies that this might be a step forward.

Mr. Snider:

That is better. We have in our budget money put in there for research, but not specifically earmarked under that name.

Mr. Redfern:

I propose a resolution that this conference on Water Quality Management express its concern to the provincial government on the need for additional research funds, to be given to the OWRC for specific research programs under the name of research.

Mr. Snider:

Thank you. Can we find a seconder?

Mr. Harry Richards, City Engineer, Brantford:

Second the motion.

Mr. Snider:

You have heard the motion. Is there any discussion on it? If not, I accept the motion.

Hermann A.R. Steltner, St. Catharines:

As far as Mr. Redfern's suggestion for research is concerned, I have made a few notes which I now intend to put in report form to be incorporated in the report.

I appreciate the opportunity given me to attend this conference and to gain better understanding of some of the efforts of the Ontario Water Resources Commission. I must say that the Commission has "set its sails full and by"--this nautical term appropriately describes the Commission's approach to the water management problems.

In order to assess my following comments on the subject of "Water Quality Management Problems", I like the audience to understand the origin of my comments.

As a marine engineer by tradition and profession, I have had the opportunity to observe many seas and lakes, and, more specifically, had to deal with problems on the Great Lakes during the last years.

One of my prime sources of information is constant alertness to observe and record all sorts of phenomena on and in the waters during my engineering and oceanographic work.

On the objectives of the Commission, as presented by Dr. Berry, I have noted three points: (1) Protection, (2) Algae, (3) Industrial waste. Although I agree that these objectives are mandatory, I feel that another basic objective would be: study or assessment of the present state of lake pollution.

Lake pollution, to my understanding, is not confined to the water only. Lake pollution includes the reciprocally affected bed and bottom as well.

Throughout this conference inferences were made on projecting future reserves, that, if all fails, we could still draw on some 90,000 cfs. of lake water, presumably referring to some flow figure. Such projection is only realistic if the degree of lake pollution is projected also.

I am presently working--without any financial assistance whatsoever--on the sampling of the bottom of Lake Ontario to study the oil content. I have received the first results of the sample analyses, which, due to the limited number, are not yet suitable for a detailed statement. However, from the results obtained, I will say that the Commission faces a problem that so far has not been projected.

Interpreting the Chairman's remarks yesterday, to attack pollution wherever found, I suggest there is great need for a full scale oceanographic investigation and I would recommend to start now with Lake Ontario. So far the bottom samples taken show oil presence ranging from 47 to 354 ppm. for the top layer of the lake bottom in direct contact with the water. Some of this water is pumped inshore for human consumption.

As soon as my present survey work is completed, I will prepare the results in a paper for proper presentation. In connection with the oil problem it is necessary to carry out applied research into the physics of oil in water to permit development of remedial methods and hydrophilous chemicals.

Such development would consider:

1. Emulsions
2. Flocculations
3. Fusions
4. Sublimations

More knowledge on this oil pollution is not only important because of human consumption of water, but its overwhelming importance lies in the danger of ensuing environmental changes, which are seldom, if at all, controlled. Such changes can be observed already, specifically for Lake Ontario;

diminishing species of fish is one indication, and the increasing growth of coarse algae another among many more signs of a minutely, but constantly progressing change of environment affecting food and hygienic conditions.

This brings me to another point in discussing "Water Quality Management Problems!", the increasing occurrence of algae and the so far applied countermeasures. Our difficulty with algae on the lakes is the lack of knowledge on explaining and understanding their presence. If we could agree that algae like all other living matter in the water is an indicator of environment, then, gentlemen, I think, we have reached the correct philosophical approach to the problem of the obnoxious dead and floating algae. I have already voiced my disagreement with chemically attacking algae; here is the reason for my disagreement: the growth of specific strains of algae I regard as a reciprocal result of the natural fluctuations maintaining the biological equilibrium in our lake waters.

Analogies to this approach can be found in agriculture. There it is established that environmental and soil conditions are indicated by weeds and plants, and I understand that an experienced agricultural biologist can draw conclusions on the prevailing growth factors to which--of course--trace elements must be added. It may be lack of information on my part, but I am not aware of any results of studies on trace elements and their impact on our Great Lakes water conditions.

From observations, it appears further that the nuisance-causing type of algae grows in relation to the oxygen content of the water. The same observations showed also that the growth of this type of algae varies with locality under comparable water--, shore--, depth--, and temperature conditions.

On dealing with this algae-nuisance, two methods were already explained to this conference; the gathering of the algae, and the spraying of the dry shore with a deodorant. But to destroy the algae in their natural environment with chemicals whose toxic and semi-toxic side-effects I doubt to be fully known, is cutting into nature's equilibrium for which we all may have to pay a penalty in the future. The biggest problem here seems to be, not to create an additional problem.

In connection with the studies for assessment of the present state of lake pollution, I would like to discuss the physical task of sampling.

In oceanographic sampling, and this is what we have to carry out on the Great Lakes, economy and efficiency is the deciding factor on the point of how much can be surveyed; and it is also obvious that such surveys are only of value if they are continuous. All problems connected with the actual work of oceanographic sample taking are elaborated on in the respective literature. The only point I wish to make clear to this conference is that these problems are the same on the Great Lakes. By adopting a proper execution policy, we can already work towards the solution of some problems.

We should reach the point where scientists prepare programs and analyze results of programs, where scientifically trained personnel work in their laboratories, and where the field work is performed by mariners, navigators, engineers and technicians. This thought is dramatically underlined as one of our eminent scientists in the oceanographic field lost his life due to a trifle technical-mechanical detail. I realize that the shortage of personnel dedicated to the seas and its problems is grave and that there is not yet an incentive nor a sign of improving this situation. If a student needs money, this need alone does not make him a dedicated oceanographer by having the chance to earn a few extracurricular dollars in field work taking samples and executing other chores between terms.

Another pressing need is the development of instrumentation - a fact, not yet fully appreciated by the instrument industry. A lot more could and should be said in reference to the need of oceanography and its importance for the survival of mankind but this would perhaps go beyond the terms of this conference.

However, there are other items where more knowledge would solve the problems on hand:

From the papers on sewage and waste treatment presented at this conference and ensuing discussions, I follow that extraction and dilution of waste is the sole consideration. I heard many admissions and quotations describing the magnitude and complexity of the problems ahead. Does all this not require a critical assessment of the physical principles involved?

Are not the garbage disposal appliances in the household sinks an indication of following to the extreme the dilution-treatment-dilution method?

Should not a method be considered by which sewage and waste is treated in its original state and disposed of without squandering our water?

For critical assessment of water quality problems we must divest ourselves of habit and ponder on the question why--with the technology in its present state--we attempt to confine the solution of the problems of sewage and waste disposal to one principal method.

From a physical point of view, I think this method to consume, disperse, dilute, extract, dilute, and consume this water again is a dangerous process resulting in problems impossible to solve as long as such practice is continued.

I would like to make a final reference to the future of such conferences as the present Conference on Water Quality Management. The sheer number of people attending this provincial conference is itself evidence of the deep public concern about the state of our water quality.

Since time is one constant factor for all decisions, should not this factor be considered by preparing the various subject papers in advance and forwarding them to the participants of the next conference in time for preparation of written comments, and then at the conference discuss the subjects under current aspects? This would certainly increase the applicable value of any next conference.

I overheard the remarks of two medical men having their conference on the same floor and passing our door here. They stopped and read aloud the sign over our head table. The one asked, "What's going on here?" "The competition is having a session," said the other.

Very seriously, a great deal of work lies ahead of us to overcome the problems of fresh water management, and our efforts on the most valuable resource, the fresh water, should never be subject to such remarks and should be free from any sentimental interference whatsoever.

We have already resigned and submitted to the fact of pollution by suggesting standards of degree of pollution and water conditions, and this in itself can be regarded philosophically as a revolution well comparable with the current world problem. The popular "let's face the facts" approach has its appeal, but will lead us nowhere if our compatible and submissive approach is not gradually changed with much needed ingenuity and science.

The words of Lord Tweedsmuir should guide our efforts: "The sea endures no makeshift. If a thing is not exactly right, it is vastly wrong."

Mr. Snider:

Thank you. I am sure we will welcome any suggestions for research, and I expect this will proceed aggressively from now on. We have Mr. Redfern's motion to put to the conference. All in favour of the motion. Carried, almost unanimously.

Mr. MacDonnell, OWRC Secretary:

Mr. Chairman, usually you don't look for remarks from the staff at this point, but there are two things which should be said for the record. Yesterday afternoon, Mr. Gavin Henderson of the Conservation Council very clearly made the point that the Commission was not doing enough in public education. And I would prefer that you would accept my remarks, as Chairman of the Advisory Board of Metro Conservation Authority Information Education Board, because on that basis, having served for five years, I am fairly qualified to speak on the subject. I think that one of the very real values of this particular conference is information and education, and I do believe that Mr. Henderson, in his good intentions, overlooked the point.

Mr. Snider:

Thank you very much, Mr. MacDonnell, for drawing that to our attention. We believe this conference has been a tremendous power to disseminating information to the public. We do believe we have gathered men here who are enthusiastic. We hope they will carry this enthusiasm back into their own walks of life, to work with every agency which will give publicity to water quality management and pollution control. We are very enthusiastic ourselves, and we intend to try to make the rest of the province enthusiastic as well.

I would like to carry this session on because we still have a lot of material to discuss. Unfortunately, however, this room is to be occupied for dinner tonight, and I am afraid we will have to adjourn this meeting.

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